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BIDS FOR RAISING THE "CRISTOBAL COLON" sunk off Santiago Harbor in the naval battle of July 3 will probably soon be asked by the Navy Department. This policy has been prompted, it is said, by the failure of the Merritt & Chapman Wrecking Co., to accomplish much toward raising the vessel and by the offers received from other wrecking companies to undertake the work without expense to the Government unless altogether successful. The contract with the Merritt & Chapman Wrecking Co., for raising the "Cristobal Colon" was executed on July 29 and involved the payment of $829 per day during operations. The same company has also been receiving $800 per day since July 6 under a general contract for the prosecution of wrecking operations on the Spanish ships, and has succeeded in raising the "Maria Teresa" and starting her on her way to Norfolk, where a commission will decide what additional compensation not exceeding $500,000, shall be paid to the wrecking company on her account. According to press dispatches from Washington, D. C., what the Government proposes to do is to annul the "Cristobal Colon" contract on Nov. 10, and to order all work to be concentrated on the "Reina Mercedes," which lies in still water and is capable of ready raising. Meanwhile, as already stated, the Navy Department will ask bids for raising the "Cristobal Colon" on the basis that the Government shall be involved in no additional expense unless the work is successful. This decision has been influenced to some extent by the arrival in Washington of representatives of a Swedish wrecking corporation, which succeeded in rescuing the British battle-ship "Howe" from a condition similar to that of the "Cristobal Colon." This company, it is stated, is not only confident of its ability to bring the "Cristobal Colon" and the other Spanish vessels to the United States, but is ready to guarantee the delivery of the "Maine" in the big drydock at the New York Navy Yard. The Swedish wreckers propose to take all the risks of failure without expense to the Government, and to rely, if they succeed, for compensation wholly on arbitration. The raising of the "Maine" is also proposed by the Acme Wrecking Co., of San Francisco, Cal. According to the reports, this company simply asks authority from the U. S. Government to raise the vessel, assuming itself all the risk and expense. Should the raising be successful the Government may have the vessel upon paying for the salvage; but in case it is not so disposed of, the wrecking company expects to get its money back by exhibiting the ship at the large seacoast cities.

THE COAST DEFENCES OF THE U. S. are reported upon by Gen. John M. Wilson, Chief of Engineers, U. S. A. The report especially deals with temporary seacoast batteries erected in consequence of the war with Spain. In addition to thirteen of these ordered, much work was done in arming the regular fortifications. Gen. Wilson says that the operations in Cuba and Porto Rico amply demonstrate the value of coast defences, shore batteries and marine mines in resisting naval attacks, and he urges the completion of the fortifications planned, as practically insuring the safety of our principal harbors. He also points out the great value and efficiency of rapid-fire guns in such coast defences. Existing projects for sea-coast defence call for the emplacement of about 500 heavy guns of 8, 10, 12 and 13-in. caliber; of about 700 rapid-fire guns of various calibers, and about 1,000 rifled mortars. The estimated approximate cost of the engineering work connected with the installation of this armament is about $55,000,000. Since the inauguration of the modern coast defence system, appropriations have been made amounting to $19,110,333, and $5,653,000 was allotted from the $50,000,000 "defence fund." Provisions have been made for mounting 283 heavy guns, 254 rapid-fire guns and 312 mortars; or, about 57% of the projected heavy guns, 36% of the rapid-fire and 31% of the mortars. This armament is placed at 71 localities in 29 harbors of the United States. The estimates for the next fiscal year aggregate $4,917,500, for gun and mortar batteries, land, protection and repair, torpedos, submarine mines, etc. Gen. Wilson again notes the material economy resulting from Congress providing funds for the completed contracts in river and harbor work; and he says that if this system is restricted to works fully justified by the interests of commerce, it is the best yet devised. The total amount expended on the improvement of rivers and harbors, in the year ending June 30, 1898, was $17,161,799. The estimate for the year 1899 is $12,883,437 for continuous work, and $15,500,341 for projects not covered by continuing contracts. Gen. Wilson asks Congress to authorize him to present special estimates for such works as are necessary to navigation.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred, Oct. 26, on the Union Pacific R. R., near Omaha, Neb. This was a rear-end collision which resulted in the death of three employees and the serious injury of one other.

SIXTEEN SAILORS WERE DROWNED in Lake Michigan on Oct. 25 as a result of the foundering of the steamer "L. R. Doty" during a severe storm. The "Doty" was a wooden vessel, built in 1893. She was 201 ft. long and 41 ft. beam with a net capacity of 1,700 tons.

A BURSTING FLY-WHEEL at the Pennsylvania Bolt & Nut Works, Lebanon, Pa., on Oct. 25, injured four men, two of them seriously.

THE TRAIN-ORDER ANNUNCIATOR invented by Mr. Harry De Wallace, and described in our issue of Oct. 27, needs a little further explanatiton as to the lettering on the dial and card. In addition to the graduation of mileage, the dial is divided into five-mile sections, each denoted by a letter. The same letters are also marked on the card, opposite the names of stations running in the sections. These letters are a check upon the accuracy of the train order. In sending out an order, the dispatcher uses the letter representinng the five-mile section in which the station referred to is situated. If the letter and station do not correspond, the mistake will be detected, and the dispatcher asked for an explanation. Incidentally, also, the letters on the card and dial are of assistance to the engineman in finding the point at which the trigger is to be set in accordance with the train order. The letters are the same for any division or run. Within the last few weeks the device has been fitted to an engine used in passenger and freight service on the Canadian Pacific Ry., between Winnipeg and Rat Portage. It was set for over 150 stops and signals, and proved to be as reliable on freight runs where switching was done, as on the long through passenger runs.

THE PENNSYLVANIA RAILROAD CO., during the Philadelphia Peace Jubilee, carried 872 975 passengers; and, as the returns are not all in yet, it is expected that the full number will be about 1,000,000. On Oct. 27 the company brought 192,142 visitors to the city. On Sept. 15, 1887, at the celebration of the centennial of the Constitutional Convention, this company brought 195,000 people to the city; but this was before the development of the present trolley system, now bringing people from a distance. Of this crowd, 380,364 people entered the city at the Broad St. Station alone.

THE VENTILATION OF THE HOOSAC TUNNEL is proposed by means of a centrifugal fan mounted at the top of the center shaft and operated by electric power from the North Adams (Mass.) Electric Co. It is stated that contracts for the work have already been let.

COMPRESSED AIR LOCOMOTIVES are contemplated by the New York Central & Hudson River R. R., for hauling trains through the Fourth Ave. tunnel in New York city in order to do away with the present annoyance from smoke. The company has, it is stated, experimented with both electric and compressed air motors during the past year and one of the air motors has given such good results that it is now proposed to equip a regular train on the Putnam Division with compressed air as a motive power. Should the method prove successful in this final test it will, it is said, be utilized in hauling trains through the Fourth Ave. tunnel.

THE PENNSYLVANIA R. R. TRAINSHED in Jersey City, N. J., will be lengthened by detaching the east end arch and moving it toward the river about 125 ft., afterwards filling the opening with the necessary new arches and roof framing. By thus moving the end arch it can be used as a traveler for erecting the new steelwork. The work is a part of the extensive station improvements now in progress at the Jersey City terminal of the Pennsylvania R. R. A complete description of the present train shed was published in Engineering News of Sept. 26, 1891, shortley after its completion.

THE TOWER FOUNDATIONS for the New East River Bridge on the Brooklyn side of the river have reached a depth of 108 ft. below high-water and bed rock has finally been struck at this depth. With the exception of the St. Louis Bridge, where some of the caissons reached a depth of 109 ft. 8½ ins., this is, we think, the greatest depth to which a caisson has ever been sunk by the pneumatic process in America. The caisson which reached this great depth of 108 ft. was the northerly of the two caissons for the Brooklyn tower and was fully illustrated and described in Engineering News, May 27, 1897. The sinking of its sister caisson has been completed for some time. It is stated that considerable difficulty has been had by the contractors in securing sufficient help to keep the work continuous since the caisson has reached over 100 ft. in depth and for some time it was possible to keep the work up only 21 hours out of the 24. Fifteen men only could be worked at once, and the maximum length of each shift was 45 minutes. The same men could work only two shifts per day. The 24 hours work thus took fourteen gangs, aggregating 210 men, besides a foreman for each gang.

A NEW NICARAGUA CANAL CONCESSION has been granted by the Nicaraguan government and was ratified by the Nicaraguan Congress, after a four days' debate, on Oct. 31. The concession grants to Edward Eyre, of the firm of Wm. R. Grace & Co., of New York, and Edward F. Cragin, of Chicago, the right to build an interoceanic ship canal, the concession to take effect when the charter of the present Maritime Canal Co. expires, on Oct. 10, 1899. The concessionaires are to form a stock company for building the canal before April 10, 1900, and 8% of all securities issued go to the Nicaraguan government. Within three years from the date of the concession its holders must open combined water and rail communication between the Atlantic and Pacific oceans. The concession is perpetual, but after 199 years one-half of the profits go to the Nicaraguan government. The concessionaires have the right to police and control the canal district and import free of duty all supplies and materials.

THE CHICAGO DRAINAGE CANAL channel through Joliet, Ill., which has been the subject of litigation since last winter, seems to be still undecided as the result of the recent court decision. The nature of the trouble may be briefly stated as follows: The Trustees of the Sanitary District of Chicago having the construction of the Drainage Canal in charge and the Commissioners of the Illinois & Michigan Canal entered into negotiations on March 11, 1898, for the prosecution of the work of the drainage channel on Section 18 at its terminous in Joliet, Ill. On this section the drainage channel is identical with a portion of the existing stream composed of the canal and the Desplaines River. This stream is dammed at convenient points, the dams being numbered from north to south and producing what are called the upper and lower basins. The drainage channel was through the upper basin. At the east end of dam No. 1, between the upper and lower basins, is located the Economic Light & Power Co., which derives a water power from the upper basin, for which it pays the Illinois & Michigan Canal Commissioners several thousand dollars a year. The drainage channel plans contemplated lowering this dam 3.6 ft., but on account of the additional volume of water which this channel would furnish there would be no reduction in the water power. This, the Trustees of the Sanitary District maintain, complies fully with the law, which requires that in constructing the channel they shall not injure any water power.

The Canal Commissioners, on the other hand, claim that the law requires the height of the dam to be left unchanged, and thus give the light and power company all the benefit of the increased head of water, which will amount to about 4,800 HP. The suit has been practically to decide this question, and the decision of the court sustains the Canal Commissioners as follows:

> In crossing the canal under the power conferring authority to do so, the plans of the sanitary district contemplate passing the water through the upper basin. We therefore have a situation which must have been anticipated by the legislature, and the last sentence of section 23 becomes of controlling importance when we remember that the plans in evidence contemplate the lowering of the crest of the dam 3.6 ft. A water power right is the right to avail of the potential energy of the water falling from the highest practicable altitude as well as to the lowest practicable depth. Any diminution of either altitude or depth must result in injury to the right. A valuable water right exists at this dam, and has been available of ever since the dam was built to utilize the water flowing at that point falling from an altitude of minus 42.4 ft. below Chicago datum. Is there any physical objection to maintaining the dam at minus 42.4 ft.? In other words, is it physically impossible to make the authorized crossing of the canal and at the same time maintain the dam at minus 42.4? Without going into an examination of the evidence it is sufficient to say that I find that such impossibility does not exist, but on the contrary it is practicable to do so.

It seems almost certain that the Trustees of the Sanitary District will appeal to the higher courts for the reversal of this decision.

THE ELECTRIC ELEVATOR EQUIPMENT FOR THE CENTRAL LONDON UNDERGROUND RY.

(With two-page plate.)

In our issue of July 1, 1897, we outlined the plans for this new underground railway in London, to which more than usual interest attaches by reason of the fact that all the operating machinery will be of American manufacture. At that time we mentioned that the contract for the elevators had been awarded to the Sprague Electric Co., of New York city. It is now our privilege, through the courtesy of that company, to present a description of this remarkable electric elevator equipment, much the largest ever contracted for, which is now being installed.

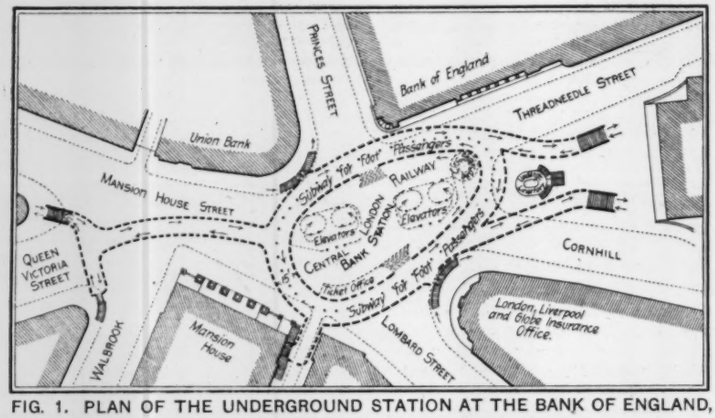

FIG. 1. PLAN OF THE UNDERGROUND STATION AT THE BANK OF ENGLAND, SHOWING STAIRWAYS AND ELEVATOR SHAFTS.

The London Central Ry. was authorized by Parliament in 1892; but owing to financial difficulties work was not begun until 1896. Since that time the excavation and construction work has been pushed until at present the tunnel work is practically completed. For the time being the section from the Bank station to the Liverpool Street station of the Great Eastern Ry., a distance of nearly ½-mile, will not be built, although the act authorizing the construction of the London Central Ry. included the right to construct this section.

The western ends of the tunnels are at Shepherd's Bush Avenue, where the entrance incline strikes the main tunnels, and from this point run almost due east under the busiest portion of London, a distance of 6½ miles. Like the other electric underground railways in London, the road consists of two parallel cast-iron lined tunnels, each carrying a single track. These tunnels are 11½ ft. diameter inside and at a depth of 30 ft. to 102 ft. below the street surface. Along the route are distributed 14 stations, and at each of these the tunnels are enlarged to 21 ft. for a distance sufficient to give platform room, usually about 320 ft. long by 11 ft. wide. At each station there are two or more entrance shafts, with stairways and 3 to 5 elevators depending upon the anticipated traffic at the station.

Owing to the necessity of running under the streets, the railway not being permitted to tunnel under the city building line, the tunnels wind in and out, twisting about to a considerable extent. Some idea of the extent of this underground station construction is afforded by Fig. 1, which is the station at the Bank of England, the eastern terminus of the road. This station is naturally the largest and most important of all, located as it is in the very heart of the city. It will occupy pretty much all of the ground under the open space in front of the Mansion House, formed by the intersection of Poultry, Cornhill, Princes, Lombard and Threadneedle streets. In its construction a subway 15 ft. wide will be built around the space tangent to the building line, as is shown in the figure. This subway will be thrown open to the public as a thoroughfare, thus permitting persons to cross from street to street without the danger of being run down by cabs and carriages. The interior of this subway will be lined with white glazed tiles, and lighted by electricity. In the center of the oval thus formed will be constructed the Bank station, which will be nothing more than a large, open room, with a steel and concrete roof carried by steel columns and supporting the street pavement above forming the street of Mansion House square. Conveniently spaced about this room will be 5 elevators, which will take passengers to and from the train tunnels about 65 ft. below. Entrance to or exit from the subway will be afforded by a number of stairways, starting from the sidewalk in front of the Royal Exchange, the Liverpool & Globe Co., the Mansion House, Union Bank, etc., and leading down into the subway.

Coming now to a consideration of the elevator work, in Table I. will be found the number and diameter of shafts at each station, and the number of elevator cars, with the height of lift, together with other particulars.

The specifications received in this country by the Sprague Co., at the time bids were asked for the elevator equipment, were very meager. The main requirements, however, were as follows:

The work included in the specifications is the find of all materials, tools and labor for the complete manufacture and installation, and, except as regards fair wear and tear, the maintenance for a period of 12 months after the opeping of the railway of all the plant and appliances necessary for working the passenger lift service of the Central London Ry.

The contract is to include the supply and fixing of all plant and machinery (except steam boilers) necessary for generating the hydraulic power required (if used) to actuate the lifts, for transmitting such power to each lift, and for return water mains along the whole line of railway, together with all machinery for actuating the lifts, as well as all cages, guides, safety appliances, fittings, etc., for a complete installation. If electric power is used to actuate the lifts, such power is to be taken from the company's mains, which pass through every station.

There are four sizes of elevator shafts: 6 shafts of 30 ft. diameter, 12 shafts of 23 ft. diameter, 5 shafts of 20 ft. diameter, 1 shaft of 18 ft. diameter. The 30-ft. shafts are to contain 3 lifts each, 23-ft. shafts 2 lifts, the 20-ft. and 18-ft. are each to contain 1 lift only; the 18-ft. shaft lift is to resemble the 20-ft. shaft lift, but the headway, above the upper delivery floor, is the same as that of the 30-ft. and 23-ft. lift shafts.

All work shall be of the highest class, to the entire satisfaction of the engineers of the Central London Ry. and the Electric Traction Co.

The whole of the work shall be completed within 16 months of the acceptance of the tender.

The time allowed for raising any lift from the low level to the high level platform is not to exceed 30 seconds in any case. As a general rule half the lifts at every station will work alternately with the other half at that station, but at many stations there will be times when the lifts may to some extent work at the same time. The train service is to be a 2 or 2½ minute one each way.

The generating plant shall be of ample capacity for the working of the whole service, with only half of the said plant in operation and the remaining half in reserve.

The steam engines, hydraulic pumps, main and return pipes, the machinery for actuating the lifts, the fittings of the lift cages, and all other necessary appliances, shall be such as will insure the highest attainable economy and facility in working and maintenance, and be least liable to breakdowns, so as to secure the safe and uninterrupted working of the lift service at all times with comfort to passengers.

The contract will include the connection of the above steam engines with the boilers of the company at their depot, in the case of hydraulic lifts; and it will include the connection of all machinery to the company's electric mains in the case of electric lifts. The buildings, engine foundations, and other masonry works form no part of this contract.

In addition, a blue-print sheet giving a proposed lay-out plan for each of the four sizes of shaft was furnished. With this meager information Mr. Sprague determined to make an effort to secure the contract, and, assisted by Mr. J. R. Furman, consulting engineer, who erected the Glasgow tunnel hydraulic elevators, and was also one of the constructing engineers for the Eiffel Tower, and Mr. Charles C. Stutz, of the Sprague Co., prepared provisional plans. Accompanied by these assistants, he took these plans to Europe in May, 1897, and shortly after arrival made tender for the entire elevator equipment. Since it was necessary first to show the superiority of electric over the hydraulic elevators for the requirements of the road, against many strong prejudices, and then demonstrate that the particular plans submitted were the best, the issue was in doubt for some time, but the decision was hastened by a number of radical propositions made by Mr. Sprague. Among these propositions were:

To buy the current from the road at one penny (2 cts.) per Board of Trade unit (K-W. hour), and, conditioned on there being not less than an average total of 20,000 single trips per day of 67 ft. mean rise, to operate the elevators under contract for three years at a cost not exceeding £1 (4.86) per 1,000 single trips, or

To install a complete electrical equipment in one shaft, as against a direct or differential hydraulic with electric pumps in an adjacent one, both having the same maximum capacity, and both operat-

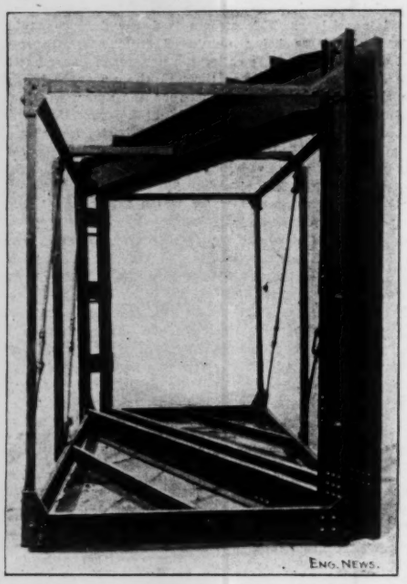

Fig. 2. View Showing the Framing of the Rectangular Type or Center Car for Three-Car Shafts.

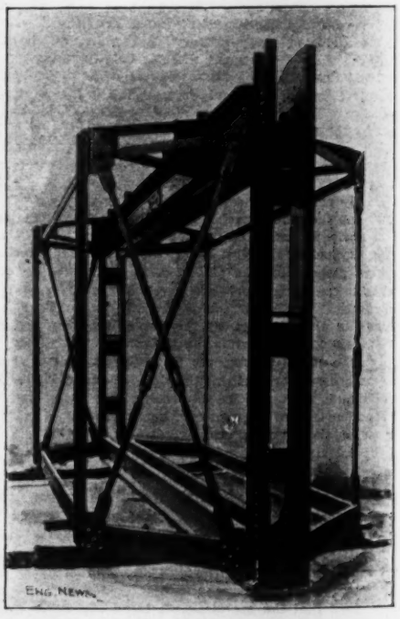

Fig. 3. View Showing the Framing of the Lozenge-Shaped Side Cars for the Three-Car Shafts.

ing under the same loads and trips, with current from the same source, and to operate at less than one-half the cost of the hydraulic, and finally,

To make a contract conditioned upon the earliest possible installation of a complete shaft equip-

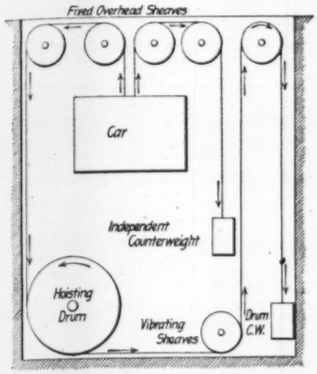

Fig. 6. Diagram Section of Shaft, Showing Arrangement of Car Cables and Counterweights.

ment, to be operated to the entire satisfaction of the representatives of both the Railway and the Traction Companies, the main equipment meanwhile to be proceeded with.

The last condition was effective, for on June 16, only four weeks after the opening of the bids, the general details of the contract were agreed to, conditioned upon the satisfactory performance of two test elevators.

in by compressed air. They are of four sizes, as follows. (See also Table I.):

1 shaft	18 ft.	diameter	with	1 car	having	172	sq. ft.
5 shafts	20 "	"	"	1 "	"	250	"
12 "	23 "	"	"	2 cars	each having	..140	"
6 "	30 "	"	"	3 "	two having	...145	"
			and	1 car	having	117	"

The number of cars specified, the circular shaft and the large loads contemplated (17,000 lbs.) required cars of very unusual shapes, some of which are shown by Figs. 2, 3 and 4. Fig. 2 is a photograph of the framing for the center car for the 30-ft. or three-car shafts. The single car used in the 20-ft. shafts is of the same shape but of larger size. The extremely heavy construction noticed is necessary owing to the size of the cars and the test requirements which specified that the safety clutch on one side could be sprung without warping the car framing.

Fig. 3 is the framing for a car used at the sides of a three-car or 30-ft. shaft, and in this the heavy central frame is also noticeable. The cantilever supporting the corners and the diagonal braces in the end contribute to the massive appearance.

The cars for use in the two-car shafts have a very peculiar unequal sided form, shown to advantage in Fig. 4. These also require that the ends be supported by a cantilever. The method employed to attach the cables to the car frame, shown in Fig. 5, is simple and at the same time very satisfactory, since it permits a nicety of adjustment which equally distributes the load upon the lifting cables. At the same time the car can run closer to the sheaves at the top of the shaft, than with the ordinary form of attachment. The steel T guides for cars and counterweights are bolted firmly to the cast-iron shaft lining. The guides for the car weigh, when milled to 1-in. thick, on the guide part, 37 lbs. per yard. Special spring guide being of oak and ceiling ornamental. Doors are provided both for regular and emergency exits.

The cable layout, or method of roping up as it is sometimes called, is diagrammatically shown in Fig. 6, in which it will be noticed that the lifting cables pass up from the car over the overhead sheaves and down to the under side of the winding drum. Wound on this drum, but in an opposite direction, are the drum counterweight cables which run under the vibrating sheaves or "vibrators," to be described later, and up overhead and down to the drum counterweight. In some cases where space is not limited this is a simple weight hanging at the end of the cables and in others it is a multiplying counterweight, Fig. 7. With this type the cables pass down under the counterweight sheaves and back up to the overhead framing; thus reducing the travel by one-half. These multiplying weights consist of a framing supporting a grooved sheave and two pendant side rods, between which are slipped cast-iron weights, each weighing 280 lbs., until the desired total weight, varying from 16,000 to 19,000 lbs., is obtained.

The rope details are interesting. They are of the best quality of mild steel, subject to approval by, and the satisfaction of, the engineers and officials of the Central London Ry., the Electric Traction Co., and the Sprague Co.

The ultimate breaking strain of ⅞-in. diameter rope is to be not less than 22 tons, and of ¾-in. diameter rope 16 tons. Such tests as the engineers require to be made at the maker's cost.
No. of strands forming each rope.....6
No. of wires forming each strand.....19
laid in two concentric circles, 12 outer wires, 6 inner wires, 1 center wire.
Main core round which strands are laid..hemp, well oiled.
Tensile test of each wire per sq. in.....85 to 90 tons.
Torsional test in length of 8 ins. wire..32 twists minimum.
The angles of lay for the wires and strands to be proportioned so that the rope shall be dead and free from any tendency to kink, spiral or spin.
All wires (excepting the center or core wire) to be of best cast steel, carefully hardened and tempered, and the wires and strands truly laid on their centers.
The approximate amount of rope is 110,000 ft. of ⅞-in. diameter, and 17,000 ft. of ¾-in. diameter, and the ropes are guaranteed for 12 months after the opening of the road.

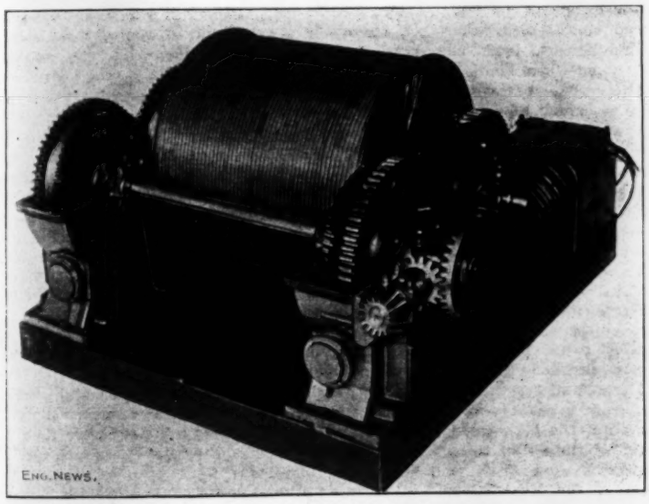

FIG. 13. HOISTING MACHINE WITH UPPER PART OF GEAR CASING REMOVED TO SHOW WORM WHEELS AND LOCKING GEARS.

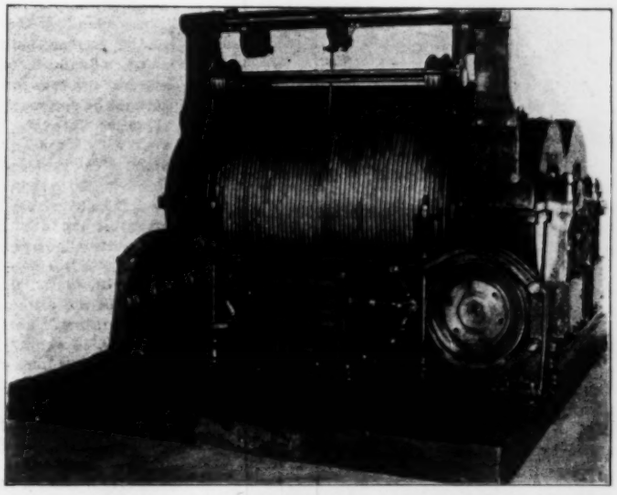

FIG. 14. HOISTING MACHINE, TYPE "S," COMPLETE, EXCEPT FOR MOTORS, SHOWING ELECTRIC BRAKE AND SLACK CABLE DEVICE.

Immediately upon getting the verbal award of the contract, supplemented simply by a letter of understanding, Mr. Sprague returned to New York, leaving Mr. Stutz abroad to collect data from which to prepare the full plans. Later a complete equipment for an 18-ft. shaft was sent from Watsessing, N. J., where the Sprague Company's works are located, to London, and installed under the direction of Mr. G. Rosenbusch, also of the Sprague Co. In the meantime, so confident was the company of the outcome of the test that plans were completed and work begun on the remaining 47 equipments. Before describing the extremely rigid tests given the specimen elevator it will be of interest to consider the plans and some of the constructional details.

Owing to the character of the soil it was necessary to make the entrance shafts circular, which made it a difficult matter to arrange elevators and stairways in them with economy of space. These shafts are all lined with segmental cast-iron plates bolted together through ribs cast around their edges, and backed with grout forced

shoes are used on the cars owing to the extreme length of car framing in comparison with the height. These shoes are yielding and do not bind even when the car is unevenly loaded.

The specifications for 45 of the car frames made up of:

12 side cars for 30-ft. shafts, 6 center cars for 30-ft. shafts, 22 cars for 23-ft. shafts, and 5 cars for 20-ft. shafts, required that:

The material to be employed should be what is known as Medium Grade Steel; to have an ultimate strength of 60,000 to 68,000 lbs. per sq. in.; elastic limit ½ the ultimate strength; minimum elongation 20% in 8 ins. The use of this grade of material is to be guaranteed by the builder.

All holes are to be drilled or punched and reamed; all edges are to be planed; no welded parts will be accepted; they must be forged. Joints must come together well and not show gaps.

Rivets to permanently assemble each car are to be supplied, and 15% in excess of actual need.

After inspection all parts are to receive one coat of graphite paint.

Calculated weights, as taken from the drawings, to be on the basis: that a steel plate, 1-in. thick and 1-ft. area weighs 40.8 lbs. 2½% will be allowed on the calculated weight of plates and angles in the riveted portion of the structure.

The whole of the order is to be delivered three months from the date of award.

The car finish is plain but substantial, the sides

The arrangement of sheaves overhead, the location of guides for cars and counterweights and the framing for the 30-ft. shafts is well shown by Fig. 8. The bottom layout or location of controllers and hoisting machinery and the relative size and position of cars is shown in Fig. 9.

We now come to the hoisting machinery upon which the success of the entire equipment is founded, and upon the working of which the continuation of the contract depended. There is not so much that is new in this very efficient machine, for it is rather an adaption of old methods with a refinement in construction of parts and details, resulting in a very perfect whole, which meets the difficult requirements of heavy electric elevator service to a marked degree.

In the first place, as will be seen from Figs. 10, 11, 12, which form the plan elevation and end view of the type "S" Duplex Tandem Worm Gear

Electric Elevator, as the machine is termed, the apparatus in its entirety is extremely simple. It is also completely self-contained, it only being necessary to attach the cables and controller wires to operate it.

Mounted upon a heavy cast-iron base are two side box-frames, seen best in Fig. 13, which, besides forming the bearings for the drum and idler shafts, form oil tanks in which the worm and worm wheels and lock gears, seen in Figs. 10, 11 and 13, are enclosed. In line with these casings, bolted to the bed plate and directly connected to the worm shafts, Figs, 10, 11, are the motors. These motors are of the 4-pole enclosed railway type. They are shunt wound, ironclad, and take current in series with each other from the feeders and the third rail. By putting the motors in series, the duty on each side of the machine is equalized for all speeds, the combination with the compensating gear arrangement later described forming an electro-mechanical couple. When running at 470 revolutions per minute they give an elevator speed of 200 ft. per minute. Fig. 15 shows the current required by the test elevator (18 ft. shaft) for running up under different loads, the current for running the car and cables alone, and the current returned to the line when the loaded car runs down. In other words, when a descending car is loaded, the motors generate and return current to the line. This factor is counted upon to materially reduce the total current consumed by the entire system.

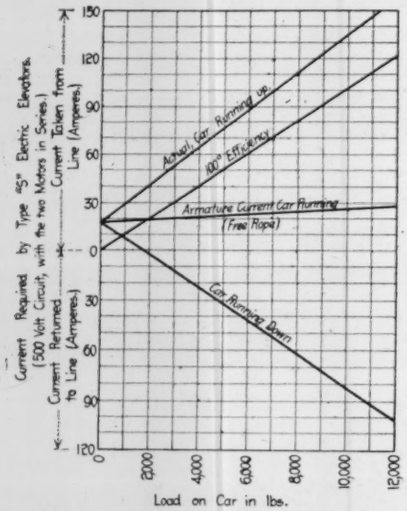

Fig. 15. Diagram Showing Curve of Relation Between Load on Car and Total Current Required for Car, in the 18-ft. Shaft.

The rest of the machine, shown in Fig. 14, consist of covers for the gears, a slack rope device, consisting of a couple of small loose pulleys mounted upon a pendulum device which holds these pulleys against the hoisting cables close to where they wind upon or off of the drum. In case the cables become slack, for any reason, the pendulum frame swings out under the influence of the weights, seen in Fig. 14, and springs a switch, thus cutting off the motor current, and also throws on the solenoid brake. This brake is clearly shown in Figs. 12 and 14, in which it will be noticed that friction pulleys are secured to the worm-shafts and are surrounded in part by two rubbing blocks held in close contact with the friction wheels by powerful coil springs. When current is passing through the solenoid contained in the metal box, seen in Fig. 14 midway between the friction wheels, the two plunger armatures are drawn in, the toggles straightened out and the brakes lifted. Any interruption of the current at once releases the armatures and allows the springs to throw on the brakes. This arrangement avoids the possibility of accident due to the breaking of a wire or the interruption of the current supply.

Referring again to the worms and gears, it will be seen in Figs. 10 and 11 that each motor drives a shaft upon which is securely doweled a right-hand and a left-hand worm which mesh with two worm wheels, one mounted upon the drum shaft and the other upon the idler shaft. There are also bolted to the worm wheels two straight gears, which are larger than the worm wheels, and mesh together, as is quite clearly shown in Fig. 13. The motors are arranged to run in opposite directions, both running in for raising, or out for lowering. In this way there is no side thrust on the drum bearings, and the usual end thrust, present with the ordinary arrangement of worm and worm wheel, is taken care of by the two worms mounted upon each driving shaft; the thrust of each worm just balancing that of the other. In this way the thrusts and side strains are so nicely balanced that the item of friction, usually a heavy one in this type of gearing, is greatly reduced. Another item contributing largely to the satisfactory operation is the use of the rotary cut worm. To assist in a full understanding of this Fig. 16 is given in which this worm and wheel is contrasted with a worm and wheel representing what may be termed ordinary practice. The greatly increased bearing surface is so well shown that no further explanation is necessary. In cutting these worms, blanks of the proper outside dimensions are mounted upon a vertical shaft, and a multiple cutter composed of a number of steel tools clamped radially to a circular disk, so that from the front the cutter resembles a gear wheel, is revolved at just the speed it would turn if driven by the worm about to be cut. The cutter is then gradually and automatically advanced until the worm has attained the proper depth and shape. To cut the worm wheel the operation is reversed and a steel worm, which has been carefully cut in the way described, is milled across the thread parallel with its axis until a cutter resembling a very large tap is formed. The worm wheel blank is then tamped on the disk, where in the former instance were the steel tools, and slowly advanced, both cutter and wheel blank revolving at the proper ratio. The pairs thus formed fit so snugly that they cannot be dropped together like the ordinary worm and wheel, but must be dropped in at an angle and turned into place. The function of the wheel straight gears is to lock the worm wheels at all times in their proper relative position. Considerable care is necessary when erecting these machines to fit the two pairs of gears and four worm gears and have the opposing thrust just balance.

One other feature of which mention must be made is the automatic idlers, vibrating sheaves, or "vibrators," as they are called, shown best in Figs. 10, 11 and 12. These are two large sheaves, each loosely mounted upon sleeve nuts which travel upon the right and left-hand screw. This screw is positively driven from a bevel gear on the extra gear shaft outside of the gear casing, Figs. 10 and 13. The pitch of the screw thread is such as to cause the vibrating sheaves to feed the rope upon or take it off of the drum at just the proper angle. The vibrator is complete in itself, and may be placed at any reasonable distance from the machine, it only being necessary to make the shaft between the winding machine and the vibrator the proper length.

In this type of machine the maximum net pull which can safely be excited upon the lifting ropes is 12,000 lbs., although the pull will not generally exceed 9,500 lbs. The rest of the load will be balanced by the counterweights which have already been described.

The safeties employed are the usual Sprague jaw clamp with certain slight modifications demanded by the unusual size and weight of cars and loads. These clamps, shown in Fig. 17, are at the bottom and at each side of the heavy car framing. They consist of a pair of heavy levers arranged to clamp the guide rails between their short arms like a pair of pliers, when their long arms are forced apart by wedges. Ordinarily, the wedges are held back, but any unusual car speed trips a catch and allows the five-coil springs, seen in the figure, to force the wedges between the rollers on the long end of the clamps which squeeze upon the girders with a force proportional to the ratio of the lever arms, the angle of the wedges and the power of the springs. In calculating the dimensions of the safeties for the elevators in question the loaded car was assumed to weigh 40,000 lbs. This amount had then to be supported by friction between the clamp jaws and the guide rails. The coefficient of friction was assumed as 15%, and the total pressure on the guide rails had, therefore, to be about 260,000 lbs., or 130,000 lbs. on each side, which made 65,000 lbs. on each clamp shoe. The ratio of long to short arm being 3,555 to 1, and the wedge 18 to 1, the total multiplication was 63.33; and $\frac{65,000}{64}$ gives approximately, 1,000 lbs. as the necessary spring pull. It will be noticed that there are five springs, each of which requires 250 lbs. to compress it, ¼-in. or 1,000 lbs. for a 1-in. compression. In service the five springs will be compressed 5 ins., and the jaws then adjusted to clamp the guide rails firmly. A further compression of 5 ins. will then be made, making 10 ins. in all or 2 ins. per spring. It will be seen that when the safeties are sprung, each spring will expand 1 in. in setting up the jaws against the guides and still have 1 in. per spring or 1,000 lbs. to clamp with.

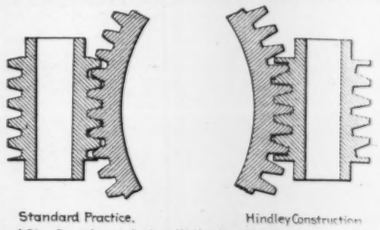

Fig. 16. Section of the "Hindley" Worm and Wheel used in the Type "S" Electric Elevator, and the Usual Form of Worm and Wheel.

To avoid any possibility of a mistake in design, a factory test was made of one of these safety clamps by springing it under working conditions (1¼-in. compression, 1,200 lbs. spring pull) upon a short section of standard guide rail. The whole was then put in a hydraulic jack and the guide rail forced one way and the clamp the other. 12 tons, or 24,000 lbs., were required to move the clamp. This would make 48,000 lbs. for both. Working backward, this gives a friction coefficient of 0.156, a close check upon the value used (0.15). The test was repeated both with the rails dry and when they were slushed with grease, and no difference was found in the results.

The clamp jaws are faced with steel with diagonal grooves cut one way across their faces. In determining the area of these faces 2,000 lbs. per sq. in. of metal in contact was assumed as the safe allowable compression.

As a further test, all parts were carefully measured, and the safety sprung 24 times as it would be in service. The measurements were then repeated while under the heaviest pressure, and no difference found.

As an additional guard against accident to passengers the oil buffers, seen in Fig. 17, are placed on all cars and counterweights. These are large and heavy dash pots, the plungers for which have tapering grooves cut in their outside surface. The grooves being large at the lower end permit the oil to flow rapidly past, thus allowing a rapid car settlement when the buffer first strikes. However, as the plunger settles the grooves narrow, less oil can pass, and the settlement gradually becomes slower, much the same as with an air cushion.

The controller by which the car is stopped or started is a small circular box about 6 ins. in diameter and 3 ins. deep with a square shank hub projecting from the center of the front of the cover upon which the operator slips a small handle when he desires to run the car. Inside are 6 contact points, two contact arcs, a lever and a spiral spring, which always returns the lever to the off position, when the operator lets go of the handle. This switch is represented diagrammatically in Fig. 18. The various points, 1, 2 and 3, connect by means of a flexible trailing cable with the controller, located at the bottom of the elevator shaft, which is nothing more nor less than a heavy resistance cut in or out of the motor armature circuits by a small "pilot" motor in turn operated by the car switch. If the operator turns

the handle to the left, as shown in dotted lines in the figure, until it comes into contact with the arm, the main circuit is closed and the elevator motors started up and allowed to run slowly. No change occurs when the arm touches point 1. By continuing around until 2 is touched, the small pilot motor begins to turn the arm which cuts out the armature resistance, with a resulting increase of elevator speed. The amount cut out can be regulated by the length of time the switch arm in the car is held on 2. If allowed to remain any length of time all the extra armature resistance will be cut out, and the armatures be thrown directly across the line. Should the operator desire to reduce the speed he touches point 1, which reverses the pilot motor, cuts in resistance and hence reduces the car speed. This gives entire control of the car, permitting a faster or a slower speed without breaking the main circuit. Point 3 increases the speed still further by cutting out part of the field winding.

Fig. 18. Sketch of the Switch in the Elevator with which the Operator Controls the Car.

The current required to operate the controller is very small, varying from ⅛ to ½ ampere. As a safeguard, the controller is arranged to automatically return to the off position in case the current on the main circuit fails or the car runs into the automatic stops at the upper or lower limit of travel. In addition the limit stops open the main circuit, thus affording almost absolute protection against accidents due to ignorance or improper operation by the elevator tender, while the safeties and oil buffers guard against cable breaks, etc.

As a further precaution, a large factor of safety was used throughout all calculations. For steel, a safe working load of from 12,000 to 12,500 lbs. per sq. in. was allowed, while for cast iron the limit was placed between 1,700 lbs. and 2,000 lbs.

As already stated, one of the elevators was set up in England and subjected to a series of tests, some of which were exceptionally rigorous and unusual.

The most important were as follows:

1. A running test of 16 hours with an average unbalanced load of 3,000 lbs.; that is, 7,000 lbs. in the car and 4,000 lbs. on the counterweight. The average current consumption was 10 K-W. hours per car mile, or 15,840,000 ft. lbs. of work done with 26,542,800 ft. lbs. of electrical energy.

2. A load test with as high as 12,000 lbs. unbalanced load, counterweight was overloaded 5,000 lbs. and 17,000 lbs. of cast iron was placed in the car. During this test the total current averaged 150 amperes.

3. A running test of the safety devices, during which the car was loaded with 14,000 lbs., giving an unbalanced load of 10,000 lbs. It was run down the shaft at full speed, and the safeties were tripped which stopped the car so suddenly that the car or free counterweight jumped up, thus making a total load on the safeties of 25,000 lbs., 14,000 lbs. load and 11,000 lbs. the car weight. The test of the cable slack device consisted in stopping the car by the safeties and noticing how much cable ran off the drum before the automatic stop same into action. In this test 3 ft. was the maximum unwound from the time the safeties were sprung until the hoisting apparatus stopped. At another time the safety on one side was sprung with the car evenly loaded, and again with the load eccentrically placed, first on half of the car near one guide rail, and then on one side of the line drawn between the guide rails.

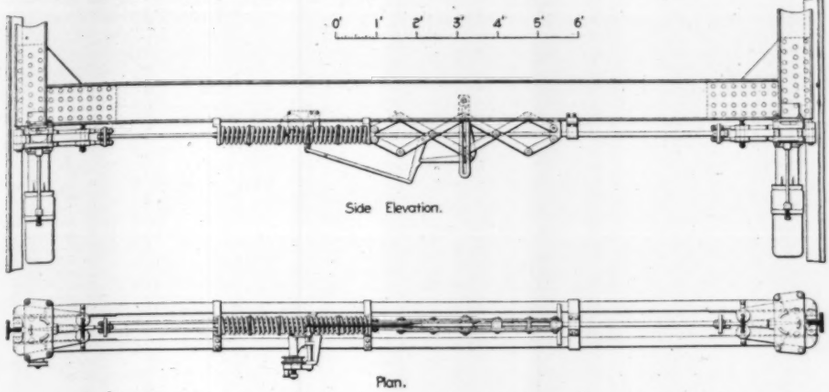

FIG. 17. CONSTRUCTION OF THE SAFETY CLUTCH USED ON ALL ELEVATOR CARS OF THE CENTRAL LONDON RY.

4. It was assumed that the pilot motor would fail to operate and the car was allowed to strike the limit stops at top and bottom.

5. The main circuit was broken with the car ascending and descending with no load and full load without the operator knowing anything about it. Going up with full load the stop was instantaneous, with light load there was a slight slide. Coming down, the motors generate on open circuit, and, therefore, have no effect on stopping the elevator unless the speed exceeds a certain predetermined limit, when the centrifugal governor operates, trips a switch and stops the machine.

6. Trip tests, running on schedule time, were made, and a series of 8 and 16 hour brake tests with the motors running at full rated load were also made.

One of the requirements was that an efficiency of 70% should be attained. In the contract test an efficiency varying from 70 to 75% was shown from the current at the brushes to the work on the ropes.

The tests were satisfactory in every respect, and the Sprague Company has since been shipping the other equipments to England. It is expected that the installation, which will be under the direction of engineers from the company, will be completed by the spring or summer of 1899.

In making estimates of costs of operation it was assumed that current would cost 1d., or 2 cents, per K-W. hour, and that it was estimated that 10 K-W. hours would be required per elevator mile. The average rise was assumed as 67 feet.

This gave $\frac{5,280}{67} = 79$, say 80 single trips to the mile, or 40 round trips to the elevator mile, 10 K-W. hours per elevator mile equals $\frac{40}{10} = 4$ round trips per K-W. hour; costing 1 penny (2 cents), or 1 round trip will cost ½ cent.

Again, asuming an average of ½-mile between stations, a two-minute headway and an average speed of 14 miles per hour, requiring 25 minutes for the trip one way, there will be 8,200 train stops. Each of these will require a down trip of each elevator to bring down entering passengers, and an up trip to remove passengers leaving; $8,200 \times 2 = 16,400$ may be assumed as the total number of one way elevator trips per day of 12 hours. There are 48 elevators and 13 stations, and $16,400 \div 13 = 1,260$ single trips per station per day. Taking three elevators as a fair number running at each station, there will be 420 single, or 210 round trips, per elevator. For 12 hours (720 minutes) we have a trifle over three minutes per round trip as the maximum time limit. In other words, it would be necessary for each elevator to make a round trip every three minutes to meet the requirements established by the train schedule.

It is interesting to note that with the exception of the ropes, not only are the motors, the entire hoisting apparatus, the car frames, sheaves, etc., but even the heavy overhead work are furnished from America, the Carnegie Co., both in the matter of price and time, largely underbidding the English manufacturers for the beams.

For the photographs, drawings and data from which this article has been prepared we are indebted to Mr. Frank J. Sprague, former President of the American Institute of Electrical Engineers and Technical Director of the Sprague Electric Co.; Mr. Charles Pratt, Superintendent of the company's factory; Mr. G. Rosenbusch, A. I. E. E., who conducted the various tests described, and is to have charge of the entire electric installation, and Mr. Charles C. Stulz, V. D. I., in charge of the entire design and construction of the machinery called for by the contract.

CAR TRUCK CONSTRUCTION AND REPAIRS.*

In my opinion the improved diamond frame or arch bar truck has come to stay for use in cars of 50,000 to 80,000 pounds capacity, and if I am correctly informed, these trucks of the above capacity are regularly used on 80% of the railways in the United States. There is, however, room for further improvement, and some of the more salient features I present for your consideration are as follows:

1. For convenience employ both bottom and top arch bars of uniform dimensions.

2. The size of arch bar should be such as to provide a proper factor of safety to carry the capacity of car.

3. In forming the angle for arch bars, have the bends made on a radius of not more than 1½ ins. instead of a radius ranging from 2 ins. to 5 ins., as done in common practice. The bending point to form the angle should start directly from the foundation of journal boxes and columns, instead of from 1 in. to 2½ ins. away. Unless this practice is followed, the arch bars when over-burdened will straighten to a line from one foundation to the other, causing a sag in the frames which increases the shearing strain on bolts and fastenings. Material that will not

* Condensed from a paper by J. C. Barber, late M. C. B., Northern Pacific Ry., presented at the September meeting of the Northwest Railway Club.

TABLE I.—Distance Between Stations, Diameter and Depth of Shafts, Number of Elevators and Data Pertaining to Elevators and Counterweights.

No. of stat'n.	Distance fr'm last stat'n, ft.	Name of station.	Shafts, No.	Shafts, Diameter.	Shafts, Height of lift.	Cars, No.	Cars, Area of each in sq. ft.	Cables, Counterweight, cables per car.	Cables, Lifting per car.	Cables, Size.	Counterweights per car, No.	Counterweights per car, Kind.
1	0	Shepherd's Bush	1	30 ft.	41 ft.	3	{2 at 145 / 1 " 117}	4	4	⅞-in.	2	Simple.
2	3,036	Holland Park	1	30 "	51½"	3	{2 at 145 / 1 " 117}	4	4	⅞-in.	2	"
3	2,040	Nottinghill Gate	1	30 "	91½"	3	{2 at 145 / 1 " 117}	4	4	⅞-in.	2	"
4	2,304	Queen's Road	1	30 "	67 "	3	{2 at 145 / 1 " 117}	4	4	⅞-in.	2	"
5	2,358	Westbourne	1	30 "	41 "	3	{2 at 145 / 1 " 117}	4	4	⅞-in.	2	"
6	3,864	Marble Arch	2	23 "	74½"	4	140	4	4	⅞-in.	2	Multiple.
7	1,926	Davies Street	1	30 "	61 "	3	{2 at 145 / 1 " 117}	4	4	⅞-in.	2	Simple.
8	2,098	Oxford Circus	2	23 "	75 "	4	140	4	4	⅞-in.	2	Multiple.
9	1,998	Tottenham Court Road	2	23 "	71 "	4	140	4	4	⅞-in.	2	"
10	2,046	British Museum	2	23 "	69¾"	4	140	4	4	⅞-in.	2	"
11	2,238	Chancery Lane	2	23 "	76½"	4	140	4	4	⅞-in.	2	"
12 & 13	...	Postoffice	{2 / 1}	23 " / 18 "	82 " / .. "	5	140	4	4	⅞-in.	2	"
						0	172	4	4	⅞-in.	2	"
14	2,569	Bank	5	20 "	80 "	5	250	6	6	¾-in.	2	"

stand bending to a radius of 1½ ins. without injury is unfit for use in arch bars.

4. Ream all bolts and rivet holes in arch bars and tie straps to fit bolts and rivets.

5. The wearing surfaces to support bolts through the top and bottom end of truck columns and journal box thimbles to have vertical bearings not less than the thickness of arch bars, with holes reamed to size, and abandon the common practice of applying the castings with holes roughly cored, which allows the columns to shift and the truck frames to get out of line.

6. Apply journal box bolts of sufficient dimensions to resist buffing and shearing forces, and abandon the expensive cost of forging, incident to turning up the ends of arch bars.

7. Attach brakes to truck frames where they will not be disturbed by forces radiating from the action of the bolster and springs, and eliminate the vertical or downward pull on the body bolster caused by the application of the brakes when attached to the car body.

8. Employ solid construction sufficient to hold side frames and journal boxes from being forced out of line when rounding curves and the usual switching derailments.

Bolsters.—The practice of employing a short bolster, or one not supported directly on the side frames at each end, but instead suspended from the channel transoms on swing hanger links or rigid hangers, is not the best construction for present service. Such a bolster has no support to resist longitudinal buffing shocks, except that of the transoms, which in turn are only supported by being riveted at their ends to the columns but not sufficient to resist service buffing forces. The short bolster and transom design of truck admits only of suspending the load from the transoms, which with age and wear deflect downward and give an inward tilting tendency to the arch bars or side frames, resulting in transferring a greater load to the back ends of the journal bearings. Investigation of this and similar construction on these lines will result in finding this to be the cause of a large percentage of hot boxes.

I would employ a bolster designed to rest directly on and in a certer line of the side truck frames, and supported between columns at each end, and in no case allow the bolster to bear against or be supported on the transoms or cross tie bars. The spring supporting the outer ends of the bolsters should also rest on a center line of the side frames, and the design should be such as would not produce an unequal ditribution of the load on the journal bearings or springs on account of the deflection of the bolster or transoms. This change in construction permits a reduction in weight and dimensions of transoms of about 30%.

Center Plates.—There has been a tendency for railways to adhere to their old standard form and size of center plates, which never had bearing surface sufficient to support even cars of 40,000 lbs. capacity. In proof of this fact you will often find cars on your repair tracks with base or flanges of the center plate cracked or settled into the wood various depths. Truck manufacturers have been compelled to employ these old center plates that were standard to the road, which have not only proved defective but have added another weakening factor to other parts on account of the base being not only too small to carry a load of the marked capacity but because it prevented solid construction. Those that are increasing the capacity of their truck should consider increasing the strength and bearing surface of their center plates proportionately.

Side Bearings.—As regards side bearings, if you are to employ a weak bolster in the truck or car body that readily deflects under loads of the marked capacity, then employ yielding or anti-friction side bearings, preferably the latter, but if your bolsters are of proper capacity to carry the load without material deflection, then the solid side bearings, which are now a serious element in producing friction, can be more safely employed.

Springs are rarely, if ever, broken through vertical action under loads, provided the bolster or load is designed to rest at all times squarely on the springs or group of springs, as lateral or torsional forces and thrusts are most destructive to both helical and eliptical forms of springs.

Brake Gear.—Power brakes, which become a necessity, furnish another destructive element to many designs of trucks unless the attachments are properly applied. To aid in reducing the load and strains on brake beams and attachments, it is necessary to connect them to truck frames instead of car body or truck bolster direct, to eliminate forces resulting from the action of the bolster and springs, which, under certain conditions, have power sufficient to cause numerous defects. If properly attached to the truck frames we find that it eliminates about 72 pieces per car, reduces first cost and cost of maintenance about 45% per car as compared with the ordinary practice of attaching brakes to car body. The modern practice of attaching brakes to truck frames that admits of their being fixed to be operated concentric with the wheel, and embodying construction that prevents the side of shoe grinding away the wheel flange, and eliminating at least 60% of the causes of solid flat wheels, and, as above stated, about 72 parts per car, has proved highly satisfactory to those employing such construction. I recently

WEATHER TABLE FOR AUGUST, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—Rain or melted snow. (Inches.) Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	66.0	85	38	47	7.1	35	NW	5.22	2.22	15
	Portland, Me.	69.8	88	54	34	5.9	25	S	3.88	1.31	15
	New York City	74.3	90	60	30	10.1	48	NW	3.12	0.81	10
	Pittsburg, Pa.	74.9	92	56	36	4.8	22	W	4.01	1.02	12
	Chicago, Ill.	71.4	93	59	34	14.6	72	SW	3.03	0.89	9
	Omaha, Neb.	76.4	100	55	45	6.8	24	SE	1.98	1.21	5
	St. Paul, Minn.	69.6	95	50	45	5 9	27	N	3.93	2.62	8
	Duluth, Minn.	64.4	86	50	36	8.8	28	NE	3.39	1.17	12
	Bismarck, N. Dak.	68.8	99	43	56	9.0	38	NW	1.35	1.00	5
	Average.	70.6	92	52	40	8.1	35	—	3.32	1.36	10
Southern Cities.	Washington, D. C.	76.9	93	57	36	4.8	30	S	8.76	4.96	8
	Louisville, Ky.	78.2	96	63	33	5.2	30	S	5.14	3.62	9
	St. Louis, Mo.	78.4	95	63	32	7.0	25	SW	0.87	0.64	4
	Savannah, Ga.	80.3	92	69	23	7.6	76	NW	22.79	7.31	20
	Kansas City, Mo.	77.2	96	59	37	7.5	24	S	5.01	2.81	6
	Jacksonville, Fla.	82.1	94	70	24	7.7	36	SE	5.44	1.84	17
	Chattanooga, Tenn.	78.2	95	66	29	4.9	26	SW	0.83	0.38	8
	New Orleans, La.	81.2	91	72	19	6.3	25	NW	6.24	2.07	14
	Memphis, Tenn.	79.8	95	66	29	5.9	40	NW	2.69	1.29	7
	Palestine, Tex.	81.6	96	66	30	4.6	20	N	3.22	1.04	7
	Average.	79.4	94	65	29	6.2	33	—	6.10	2.60	10
Western Cities.	Helena, Mont.	69.0	93	46	47	6.5	27	NW	0.71	0.39	5
	Port Angelee, Wash.	58.3	82	46	36	6.2	22	NW	0.17	0.17	2
	San Francisco, Cal.	57.0	72	47	25	14.6	38	W	T	T	0
	Salt Lake City, Utah.	76.8	97	58	39	6.0	29	NW	1.35	1.04	4
	Santa Fe, N. Mex.	67.7	85	52	33	5.8	25	S	4.00	1.45	12
	Denver, Colo.	72.6	95	50	45	7.2	40	SW	0.96	0.59	6
	Yuma, Ariz.	—	—	—	—	—	—	—	—	—	—
	Average.	66.9	87	50	38	7.7	30	—	1.20	0.61	5

counted in one train (36 cars) 84 brake shoes, with top ends of the shoes dragging against the wheels, which were worn off due to friction from 2 to 4 sq. ins.; this, together with the 72 brake beam guide pins nearly cut in two from friction, would present a proposition for us to figure the cost of extra fuel consumed annually to grind these parts away, not taking into consideration the expense incurred in loss of time, delays and accidents to trains; our train despatcher's sheets frequently note trains being delayed or making slow time with that same old excuse which is so familiar to us all, "delayed on account of heavy pulling train."

Box Lids and Dust-Guards.—A good dust-proof journal box lid and dust-guard form cheap and desirable additions to construction that prevent hot boxes and swell the economies in lubricating rolling stock. A good dust-proof lid, in my mind, is more essential than the dust-guard, as all dust lodging in the front end of box is forced under the journal by the packing spoon in hands of the oiler. As a matter of fact, worn-out dust-guards form a small factor towards hot-box troubles, but when we consider that railways have thousands of journal boxes running with imperfect dust-guards that never get hot, we are inclined to decide that the journal bearings, with loads unequally distributed thereon through faulty truck construction, are the paramount cause of 60% of the hot-box nuisance.

Metal Trucks.—Metal trucks are gradually superseding the various wood and grey iron forms of trucks. The prices of the metals that we could employ in trucks are as follows: Commercial rolled steel shapes, 1⅛ cts.; grey iron or common cast iron, 1½ cts.; malleable iron, 2¾ cts.; pressed steel from 3 cts. to 4 cts.; cast steel, 4 cts. to 6 cts. Commercial steel shapes are not only the strongest, lightest and most convenient to procure, but show for themselves a saving in first cost over other metals quoted; and from careful observation and personal investigation made from time to time during the past three years, I am convinced that these steel shapes combined with good malleable iron produce a truck, when designed on modern lines, with greater efficiency and units of strength than many other metals. In proof of this I have reports of a large number of trucks, made of the above material, that have been operated in almost continuous service for the past few months under loads of 70,000 lbs. at an expense of less than 1½ cts. per car per month. This statement does not include the cost of lubricating.*

Lateral Motion Trucks.—Lateral motion freight car trucks of the old swing hanger type, are being gradually discarded, owing to the large number of parts failing in service under heavy capacity cars. Many have replaced these trucks with the various other forms now on the market, while others, who still believe in certain economies the lateral motion trucks provide that rigid trucks do not, are now employing a more modern lateral motion truck constructed on lines which eliminate the former objectionable features, effecting a reduction of parts ranging from 150 to 300 pieces per car.

The question of introducing lateral motion in trucks, or employing one that is flexible enough to admit of its being easily adjusted to service, is seriously being considered, if not already adopted by many roads, for the reason they provide for greater economies than the common rigid form of truck. An officer on one of the large railway systems in the Northwest, whose standing as an engineer is high, is on record as saying: "We notice a great difference in favor of our improved lateral motion truck in way of reducing flange friction against rail and the cushioning of the forces and blows on truck frames, wheels, axles, and reducing the wear on M. C. B. coupler, knuckles, etc., and especially so in our cars of 60,000 lbs. capacity and over, as compared with our rigid or swing hanger style of truck."

*An article on "Metal Trucks for Freight Cars" was published in our issue of Sept. 22.

THE U. S. SIGNAL CORPS is officially reported upon by Gen. A. W. Greely, Chief Signal Officer U. S. A. As to the work of this corps in Cuba, the report details the arrangement and installation of electrical and other appliances for quick communications between the army and Washington. Gen. Greely intimates that the work of the corps was handicapped because it was not allowed to take to Cuba the telegraph train fitted out at Tampa. The use of the war balloon is strongly commended, and its utility was demonstrated in the campaign, but Gen. Greely disclaims any responsibility for forcing this balloon on to the skirmish line, where it caused serious loss of life by disclosing the position of the troops. The report claims for the corps the credit of locating Cervera's fleet in Santiago harbor. This was done by Col. James Allen, and later verified by Lieut. Col. Joseph E. Maxfield, both of the Signal Corps. Col. Allen telegraphed to the chief signal officer on May 19, the day Cervera entered the harbor, that "five Spanish vessels arrived at Santiago de Cuba; have notified Admirial Sampson, etc." This information was sent to the President and prompt orders were at once given for the blockade of Santiago harbor. Col. Allen continued almost daily to send valuable information from Santiago. The report deals largely with these and similar services of the Signal Corps, and Gen. Greely says that the corps failed to receive, from Gen. Shafter, even a notice that it was to participate in the Santiago campaign.

SPECIAL FIREPROOF CONSTRUCTION IN THE U. S. APPRAISERS' WAREHOUSE, NEW YORK CITY.

By Gunwald Aus, M. Am. Soc. C. E.*

This building occupies the entire block bounded by Greenwich, Christopher, Washington and Barrow Sts., in New York, and covers an area of about 53,000 sq. ft. It has ten stories and a basement, and the ridge of the central skylight is about 192 ft. above the street. The three lower floors with a temporary roof were completed in 1894 under a limited appropriation made by Congress in 1888. In 1895 Congress extended the limit of cost of the building and appropriated a sum sufficient to proceed with the construction. The walls of this building are of brick, with granite trimmings, and are self-supporting, and columns built into the walls support floors and roof.

After consultation with Mr. Theodore Cooper, C. E., it was decided to construct the steelwork of the building for an assumed "live load" of 325 lbs. per sq. ft.; that is to say, the floor beams

*Engineer of Steel and Iron Construction, Office of Supervising Architect, Washington, D. C.

were proportioned for the calculated dead load and a live load of 325 lbs. per sq. ft. The girders were designed for the dead load and two-thirds of the supported area covered by a load of 325 lbs. per sq. ft., it being assumed that in a building of this kind at least one-third of the floor area is kept open for passageways. The beams and girders in the roof are proportioned for the calculated dead load and a live load of 40 lbs. per sq. ft. The columns are proportioned for the dead load and two-thirds of the full live load on two floors, and a gradually decreasing percentage on all other floors. The foundations are of concrete and stone resting on a compact bed of coarse wet sand. They are proportioned so as to impart a pressure of four tons per sq. ft. to the sand under the load for which the basement columns are proportioned.

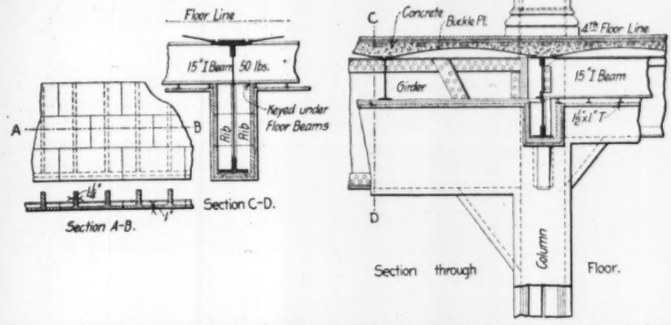

FIG. 1.—DETAILS OF FLOOR CONSTRUCTION AND COLUMN AND GIRDER FIREPROOFING, U. S. APPRAISERS' WAREHOUSE, NEW YORK.

The three lower floors are built of 24-in. I-beams supporting terra cotta arches of generally 11 ft. 6 ins. and 15 ft. 4 ins. span. A general section showing the floor construction, and a description of a test made on these arches, appeared in Engineering News of Nov. 7, 1895. While this construction is economical in cost, it is enormously heavy, the calculated dead load being from 120 to 130 lbs. per sq. ft.

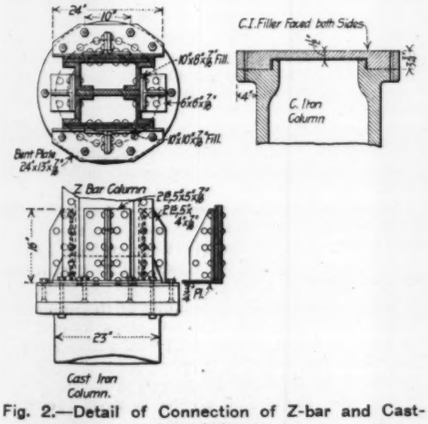

Fig. 2.—Detail of Connection of Z-bar and Cast-Iron Columns.

The upper seven floors are built of buckle plates riveted to the top flanges of I-beams spaced 4 ft. 7 ins. c. to c. (Fig. 1). The plates are ¼-in. thick and are covered with a coating of asphalt at least ¼-in. thick on buckles and ⅝-in. to ¾-in. thick in all valleys, so as to protect effectually both plates and beams against water leaking through the flooring. On this asphalt is a deadening of cinder concrete. From below, the beams and floor plates are protected by a ceiling of plaster on expanded metal fastened to light T-irons. The plaster selected is a comparatively new material, "Asbestic Plaster," which is manufactured from the waste material in the asbestos mines, and which appears to have splendid fire-resisting qualities.

If, however, the combined action of intense heat and cold water should destroy this ceiling, I am strongly of the opinion that no part of the solid steel floor would collapse, as its continuity would prevent any one beam from buckling, so that this floor is as nearly fireproof as it is practical to build one. The cost of such a steel floor is, of course, considerably higher than that of a concrete or terra cotta floor, but then this floor weighs only 65 lbs. per sq. ft. against 100 to 130 lbs. per sq. ft. for the other constructions, and it is certainly much more rigid.

The columns in the basement and first and second stories are of cast-iron and have terra cotta fireproofing. Above the third floor all columns are of Z-bars, Fig. 2, and have concrete fireproofing. The columns were first wrapped with expanded metal and then a 2½-in. thick layer of concrete was formed around it by enclosing the column in a wood form and tamping the concrete in place. The roof is built of cinder concrete on expanded metal. The metal was stretched on top of the roofbeams and the cinder concrete rolled in place on a wooden platform built in between the beams. On the concrete is placed a covering of asphalt 1 in. thick, put on in two layers, ½-in. thick.

A novel feature in this building which deserves to be mentioned is the fireproof, or rather fire-retarding screen, Fig. 3, which encloses the light well. This light well is 64 × 46 ft., and in it are located the ten freight elevators. In case of fire it would act like a chimney and rapidly communicate fire from floor to floor. To prevent this a screen was built. It is constructed of wire glass in iron sashes, protected on the side facing the warehouse with heavy wire netting. The elevator openings, whose doors close automatically as soon as the car leaves a floor, form the only openings in this screen. As the elevator doors are of sheet iron and are always closed, a fire will be confined to the floor where it started long enough to give the firemen a chance to put in some effective work. All openings in the outer walls are protected by corrugated steel shutters.

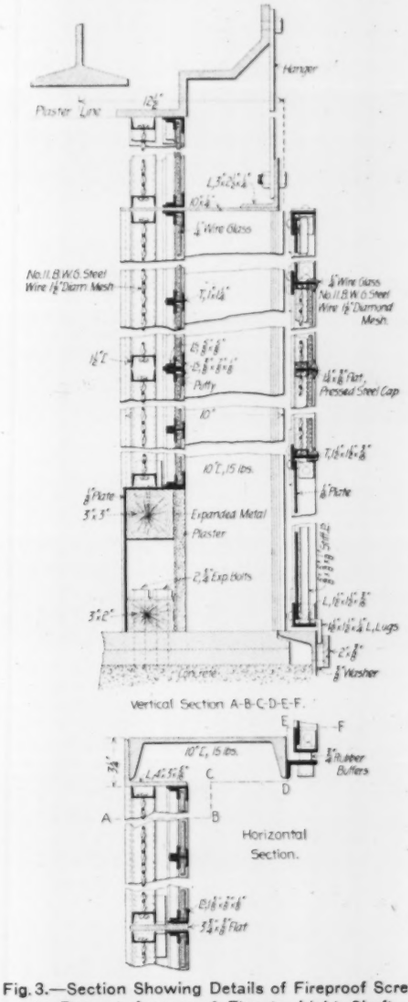

Fig. 3.—Section Showing Details of Fireproof Screen to Prevent Access of Fire to Light Shaft.

The contract for the steel frame, including buckle plate floors above the third floor, was awarded to Post & McCord, of New York city. It amounted to 6,800 tons, of which 1,700 tons were buckle plates. The erection was commenced on Nov. 15, 1896, and completed on April 18, 1897. An idea of the amount of work done can best be formed from the statement that the shop rivets used weighed about 334,000 lbs., the field rivets about 210,000 lbs., and it required 6,690 gallons of red lead to paint the steel after erection. This paint was nearly all applied by a compressed air machine, which worked very satisfactorily. I am indebted to Messrs. Post & McCord for these data. Including steel and iron in the three lower floors, and other steel not included in the above contract, the grand total of steel and iron in the building amounts to over 11,000 tons.

All steel above the third floor is "Open Hearth," of 60,000 lbs. to 68,000 lbs. ultimate strength. Holes in material over ⅝-in. thick were punched ⅛-in. small, and reamed to size. At the shop all steel was given a coat of linseed oil, except the buckle plates, which were given a coat of Edward Smith & Co.'s asphalt paint, as it was thought that the hot asphalt, to be put on after erection, would burn the oil. The Supervising Architect, James Knox Taylor, has kindly permitted me to publish these details.

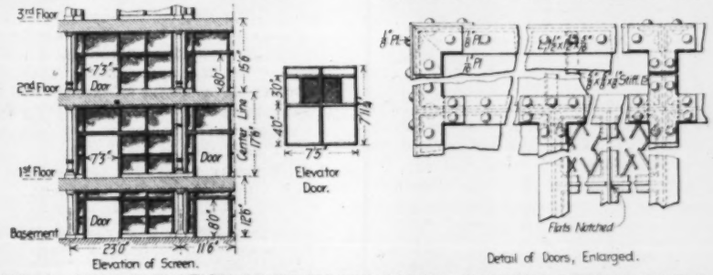

FIG. 4.—HALF ELEVATION OF FIREPROOF SCREEN SHOWING DETAILS OF ELEVATOR DOORS.

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Our attention has been called to the fact that the heavy grain train hauled on the New York Central by a single locomotive recently and noted on p. 257 of our last issue, was not nearly as heavy as the coal train hauled from Altoona to Columbia, on the Pennsylvania R. R. on Aug. 9 last, and noted in our issue of Aug. 18. As both of these trains were of phenomenal size, however, we have tabulated the principal particulars concerning each below:

	Pennsylvania.	N. Y. Central.
Number of cars	130	81
Weight behind tender, tons	5,212	3,478
Freight carried, tons	3,692	2,000*
Distance hauled, miles	161	140
Time consumed	17 h. 13 mins.	12 h. 55 mins.
Average, miles per hour	9.4	10.8
Locomotive	Consolidation.	Mogul.
Weight on drivers, lbs.	186,000	123,000
Driver, diameter, ins.	56	57
Cylinders, ins.	23½ × 28	20 × 28

*Obtained by estimating the average weight of grain at 50 lbs. per bushel.

It may be noted that the Pennsylvania train made the run from Altoona to Harrisburg at an average speed of ten miles per hour. The maximum grade on this section was 12 ft. per mile.

Another engineering association will soon be added to the already long list of such associations, and will have the descriptive but somewhat cumbrous title of the American Railway Engineering and Maintenance of Way Association. It will be open to all officers having charge of railway construction work, engineering work or maintenance of way. Mr. A. Torrey, Chief Engineer of the Michigan Central R. R., is chairman of the provisional association, which will complete its organization and adopt its constitution at a meeting next March. It is reported that a large number of officers have already signified their intention of becoming members. This association is the outcome of a somewhat unfortunate action taken by the Roadmasters' Association of America at its meeting held at Denver in September last. An amendment to the constitution was submitted, changing the name to that of "The Railway Maintenance of Way Association," on the ground that the title of roadmaster is not distinctive, and that the association has grown beyond the scope of the roadmaster's work alone. Under present conditions, the work of track maintenance is being put more and more under the direction of engineers, and is becoming a department requiring more skill and technical knowledge than is possessed by the ordinary typical "roadmaster," who is merely a foreman of high grade. Many roadmasters (or supervisors, as they are termed on some roads) are engineers, and the title of roadmaster as applied to the higher officers of this department is, therefore, falling into disuse, and the title of engineer of maintenance of way is becomong more general. For example, Mr. R. Caffrey, General Roadmaster of the Lehigh Valley R. R., who was recently president of the Roadmasters' Association, has had his title changed to that of Engineer of Maintenance of Way. It is true that all officers in charge of maintenance are eligible to membership in the Roadmasters' Association, and many engineers are members. In fact, we find 21 engineers (5 chief, 5 assistant, 4 engineers of maintenance of way, 3 resident and 3 division engineers) by a rough canvass of the list of members. It was felt by the progressive element in the association that the name should more fitly represent its present aim and membership. The conservative element, however, strongly opposed the change, being apparently fearful that the old-time "practical" roadmasters would eventually be crowded out by the "engineer." This, however, is a stage of evolution which will take place, and is already taking place, and no such action as holding on to a name can stop it. We are not sure, however, as to the wisdom of organizing an independent, and, in some respects, opposition, association, as this action will hardly conduce to harmony or good feeling between the various grades of men employed in the maintenance of way department. If all the engineers (by title or otherwise) who are now members of the Roadmasters' Association should resign and join the Maintenance of Way Association, the former would lose the most valuable element of its membership. It seems to us that a better plan would have been for the maintenance-of-way engineers to join the old association and thus gradually elevate its standing, and at the same time make the progressive element strong enough to carry out such changes in title and management as might from time to time be desirable. In a recent issue we deprecated the increase in the number of technical associations, and we are obliged to doubt the wisdom of creating this newest addition to the list.

We give considerable space in this issue to description and illustration of the largest and most notable elevator plant ever constructed, that for the Central London Ry. Additional interest centers about this plant in view of the fact that the contract for the entire equipment was taken by an American company, the Sprague Electric Co., much to the chagrin of English machinery manufacturers, and that the selection of this elevator was made by English engineers after a long series of tests in which they exhausted their ingenuity in devising methods of determining the safety and efficiency of the apparatus. The selection of American elevators for so extensive and important a plant, however, was certainly to be expected, for the experience of engineers and manufacturers in the United States in the design of high speed and large capacity passenger elevators is far in advance of that of any other country.

THE RESPONSIBILITY FOR THE INADEQUATE APPROPRIATION FOR THE NEW YORK CANALS.

The State Engineer and the Superintendent of Public Works of New York have recently made public their replies to the criticisms upon the work of their respective departments made in the report of the Canal Investigating Commission. These replies we have abstracted quite fully in this number, for the matters at issue are almost all of them questions of much interest to the engineering profession, and it is, moreover, the policy of this journal to give space for a fair presentation of both sides of any question in controversy.

The position of Messrs. Aldridge and Adams is substantially a denial, both general and specific, of the charges contained in the Canal Commission's report. They declare that the work has been honestly carried on by their departments, with as great efficiency as could possibly be expected; and that the Commission's charges in the main really amount to no more than an opinion on the part of the Commission and its engineers that the work could have been better done by other methods than those adopted. The difference between accusing a public officer of bad judgment, and of wilful corruption, is, of course, manifest.

Finally, Messrs. Aldridge and Adams make detailed replies to the instances in which specific irregularities were charged in the Commission's report. These matters, however, will doubtless be made the subject of further official inquiry; and it is certainly fair to suspend judgment upon them until the results of such inquiry are made known. The canal investigating commission was not a judicial body; its object was to investigate the work done rather than the personal responsibility for errors or irregularities. Its investigation, moreover, was conducted without the safeguards against error and injustice which exist in a court of law; and it is manifestly unfair to base conclusions as to the guilt or innocence of any man or body of men upon the investigation of such a tribunal.

Aside from these questions of personal responsibility, however, the controversy over the canal work has brought to light many questions of general interest to engineers. At the outset is the matter of discrepancy between the preliminary estimates and actual cost of engineering works. Messrs. Adams and Aldridge correctly say that what the voters of New York State are chiefly kicking about is that they were assured that $9,000,000 would accomplish a certain piece of work, and after they have paid over the money and it has been spent, they learn that two or three times as much will be required. It seems to be entirely clear that the responsibility for deceiving the people rests with that irresponsible body known as the Executive Canal Committee, made up of delegates from the principal commercial organizations of New York. They lobbied a bill through the legislature calling on the voters of the state to approve a state bond issue of $9,000,000 regardless of previous rough estimates in excess of this amount which the State Engineer had furnished; and they carried on a vigorous campaign to secure a favorable vote on this bill, in which they assured the people that this amount would be sufficient to complete the work.

It was hardly to be expected that Messrs. Adams or Aldridge would take the responsibility of opposing this appropriation, especially as there was then no absolute proof that the $9,000,000 appropriation might not be adequate. After the money was available the view they took was that it was their duty to perform the work ordered by the legislature, so far as the funds would permit, and they appear to have made considerable effort to bring the work within the limits of the appropriation. The first survey made in the spring of 1896 showed that the work would cost about $15,000,000; but the State Engineer ordered that the scope of the work should be restricted and everything that could possibly be delayed should be omitted, hoping in this way to keep the cost of the work down to the $9,000,000 mark.

It is a difficult question as to just when it became Mr. Adams' and Mr. Aldridge's duty to undeceive the people. That it was their duty to do this at some time is beyond question, and is proved by the fact that when the "cat was at last let out of the bag" it was on these two officials that popular condemnation chiefly descended. We believe, after careful consideration, that it was their duty as public servants to stop the expenditure of the state's money as soon as it became clearly evident that the work ordered by the legislature could not be accomplished by the funds which it had provided. If they did not go so far as to order work stopped on contracts already let, it was at least their duty to refrain from letting further contracts as soon as it became clear that the work would overrun the appropriation. Now, the first batch of contracts, amounting to $3,825,000, was let in

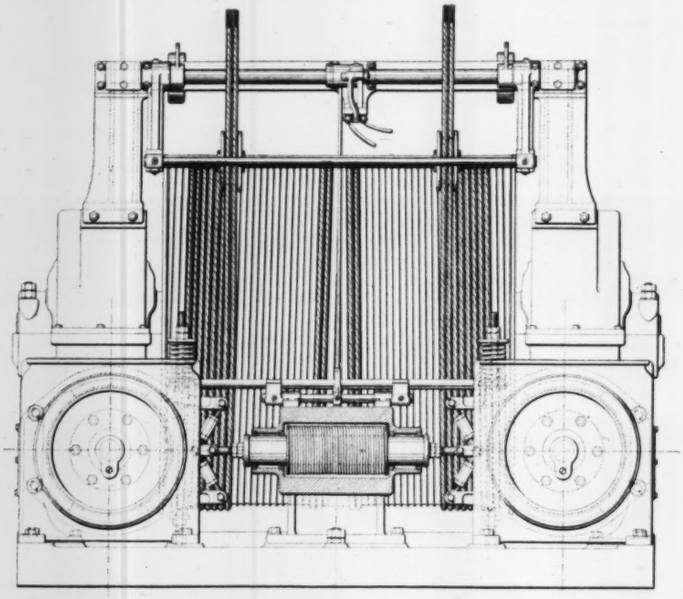


FIG. 12. END ELEVATION OF TYPE "S" DUPLEX TANDEM WORM GEAR ELECTRIC ELEVATOR.

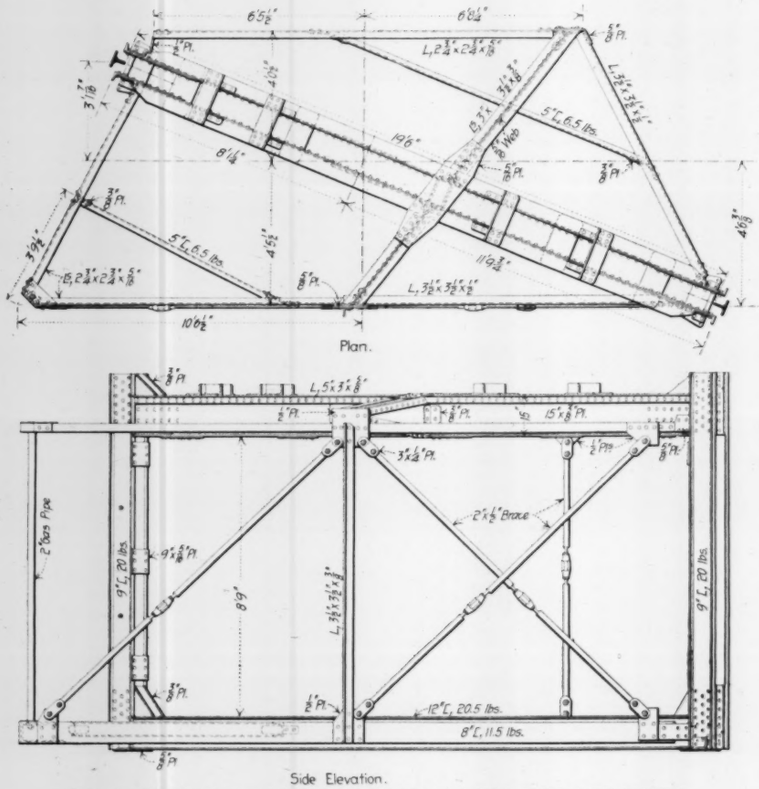


FIG. 4. FRAMING OF UNEQUAL SIDED CAR FOR TWO-CAR SHAFT.

ELECTRIC ELEVATORS FOR THE CENTRAL LONDON UNDERGROUND RAILWAY.

Sprague Electric Elevator Co., New York City,

Designers and Builders.

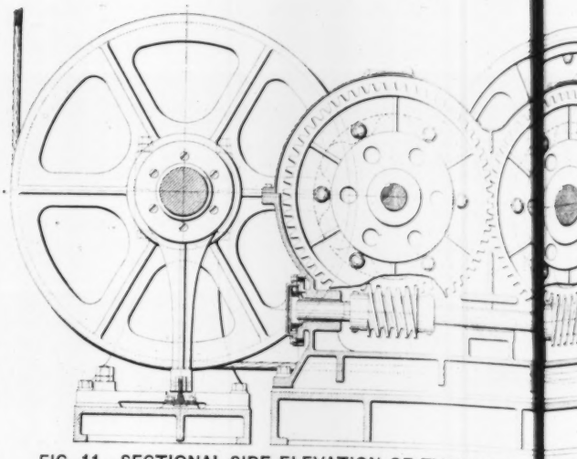


FIG. 11. SECTIONAL SIDE ELEVATION OF TYPE "S" DUPLEX TA

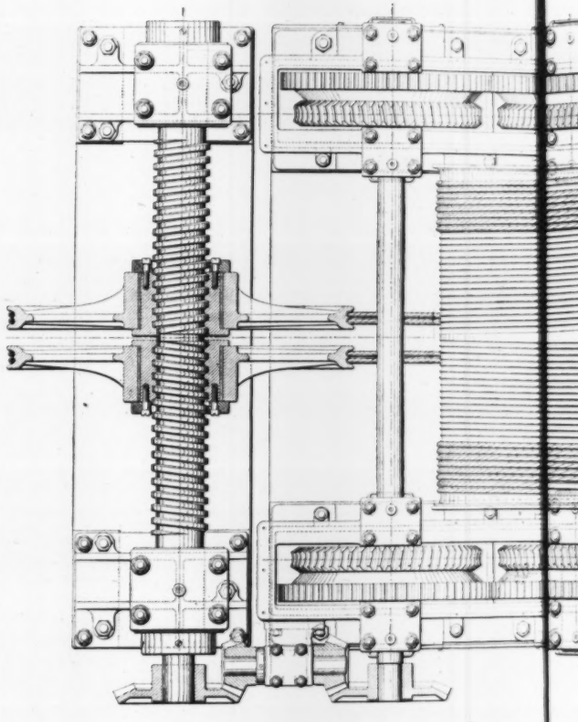


FIG. 10. PLAN OF TYPE "S" DUPLEX TANDEM W

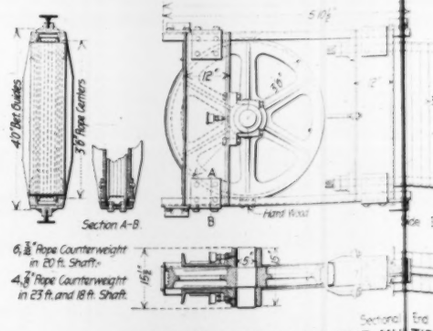
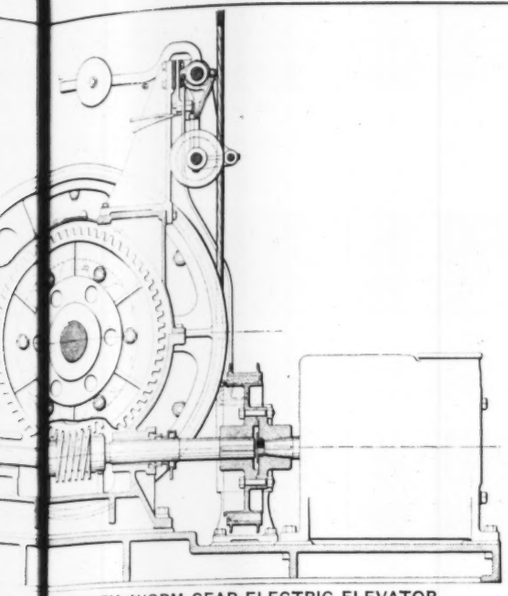
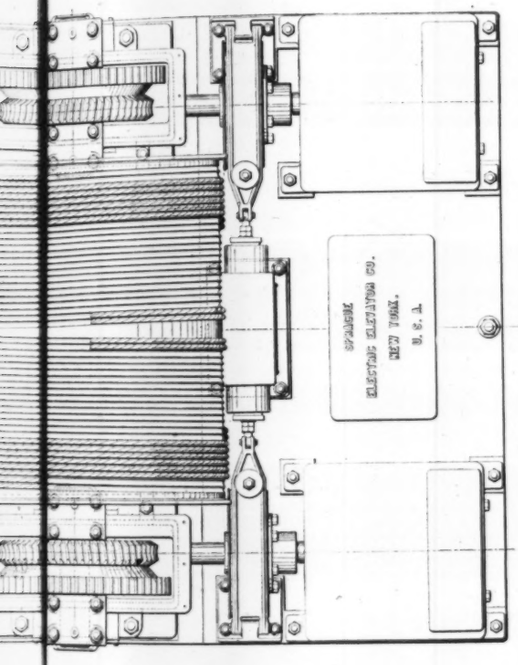


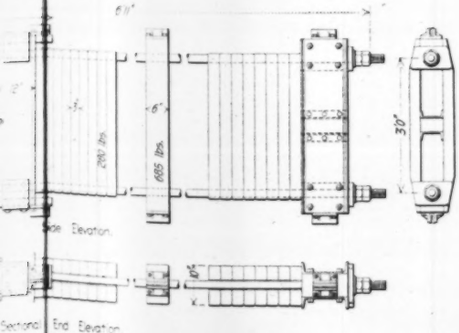
FIG. 7. DETAILS OF THE MULTIP



DUPLEX TANDEM WORM GEAR ELECTRIC ELEVATOR.



TANDEM WORM GEAR ELECTRIC ELEVATOR.



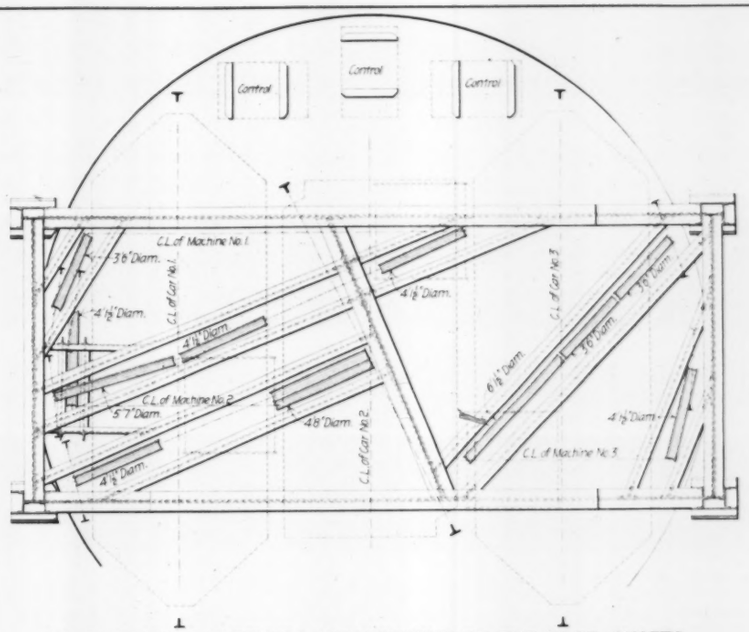


FIG. 8. PLAN OF OVERHEAD ARRANGEMENT OF THE 30-FT. SHAFTS.

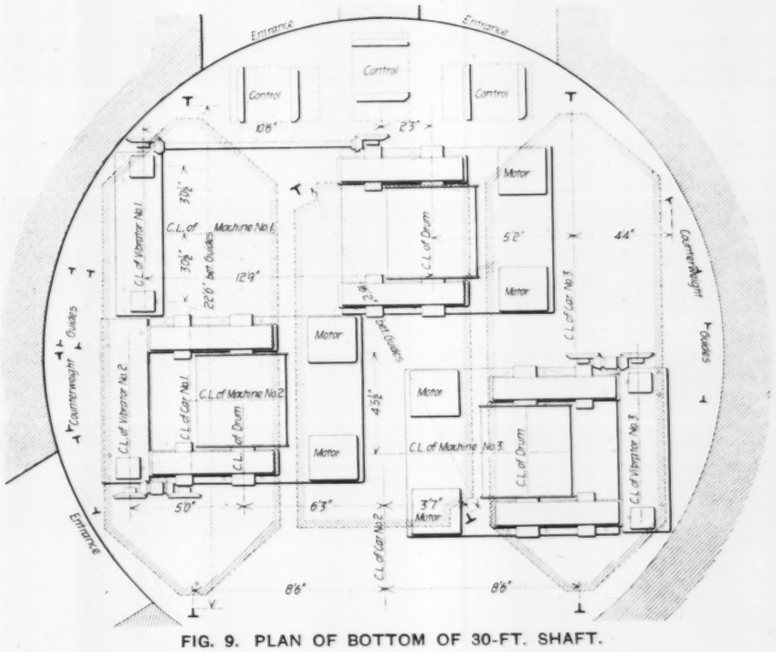


FIG. 9. PLAN OF BOTTOM OF 30-FT. SHAFT.

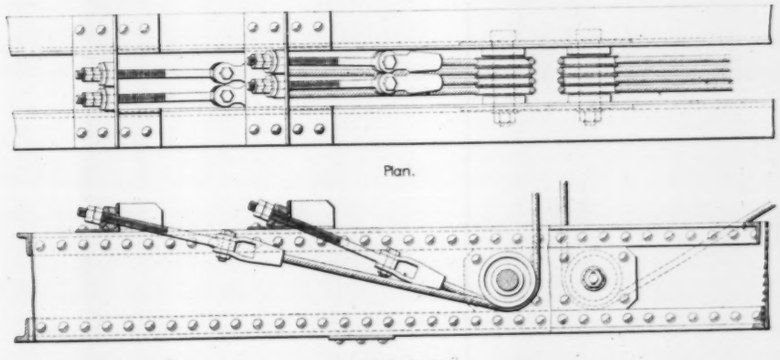


FIG. 5. METHOD OF ATTACHING CABLES TO THE FRAMING OF ALL CARS.

the fall of 1896. Bids on the second batch of contracts were received Aug. 24, 1897, and at that time, we believe, it was known to Messrs. Campbell and Adams that the work was certain to overrun the appropriation. In fact, this was publicly stated in September. Yet not only was the second batch of contracts let in the face of this knowledge, but months afterward additional contracts were let when the whole state was in an uproar over the news that the canal appropriation was inadequate. We understand that Superintendent Aldridge claims that the law was mandatory and he had no option in the matter. We know, however, of no punishment which could or would have been visited on him or the other members of the canal board had they, as soon as the real situation was apparent, stopped the letting of further contracts and saved the four or five millions still in the state treasury from going "into the ditch." We are of the opinion that had they done this they would have been supported in their action both by public opinion and by the courts.

In our abstract of Mr. Aldridge's reply to the Commission we have included a curious table which he gives in support of the statement that the preliminary estimate for the canal improvement work was no further out of the way than original estimates for other great public works have been. We have done so because we wish to combat emphatically the too common statement that engineers' estimates of the cost of works are wholly unreliable. The $9,000,000 appropriation, as we have seen, was not an estimate or even a guess of the cost of the work it was provided to accomplish. It was a guess at what the people could be induced to give—nothing more nor less. The "engineer's estimate" for the Hoosac tunnel was not an estimate in the present day sense of the word. It was made when engineering was in its infancy, and when absolutely no precedents for a work of such magnitude existed. It was a guess, pure and simple. We know of no "$12,000,000 estimate" for the Chicago Drainage Canal. If such an estimate was made, it was, we venture to say, a mere guess. As a matter of fact, the cost of actually constructing the Chicago Drainage Canal has come very close to the first official estimates of cost which were made by its Chief Engineer, Mr. Isham Randolph, at the outset of the work.

We might in a similar way review the other instances which Mr. Aldridge presents in his table; but it is not needful. What we wish to point out is that the "guess" of a promoter or a committee, or any other man or body of men, is not an "engineer's estimate." There is just one way to make a reliable engineer's estimate, and that is to make actual detail surveys, compute the quantities of materials of each kind involved, and on this basis ascertain the probable cost of the work. If the people who furnish the funds for public works prefer to take guesses in preference to engineer's estimates, they must not complain if they suffer disappointment. The Panama Canal dupes, for example, were satisfied with De Lesseps' guess as to the cost of the canal, and could not wait for engineer's estimates. They paid some $250,000,000 for their folly. The New York Capitol and the Hoosac tunnel, instanced by Mr. Aldridge, are two other pieces of work which would never have been undertaken had their enormous cost been foretold in advance.

On the other hand, such recent and notable works as the Boston subway and the Philadelphia subway are examples of large and costly pieces of engineering work, involving many features of novelty, which are carried out within the engineer's original estimate. Such instances as these show conclusively the value of careful estimates as a basis for any engineering work. The work may, indeed, proceed without them, but always at the risk of such disappointment and loss as befel the Panama investors, and has now come home to the taxpayers of New York.

LETTERS TO THE EDITOR.

Capacity Tests of Mississippi River Dredges.

Sir: In the article on "Dredges and Dredging on the Mississippi River," in your issue of Oct. 13, Table No. 2 (p. 239), seems to contain marked peculiarities in the columns indicated as "minimum" and "maximum," whereby a large number of figures in the former are in excess of those in the corresponding "maximum." Are these typographical errors, or is the table not understood by the writer?

Yours very truly,

L. Y. Schermerhorn, Pres. American Dredging Co.

Philadelphia, Pa., Oct. 22, 1898.

(The seeming discrepancy is easily explained. Each column represents one test, and the two tests for each dredge are those showing the minimum and maximum capacity, or sand pumped per hour. In the test showing the minimum capacity, however, it does not follow that all the conditions of working will be at a minimum: As an example, in comparing the two tests of the "Alpha," it will be seen that during the test showing the minimum capacity, the efficiency of the plant and the steam pressure of the boiler were higher than in the test showing the maximum capacity. Also in the tests of the "Zeta," the column for the minimum capacity shows that during this test the amount of material pumped was greater than during the maximum test, but as the amount of sand was only 8.1% instead of 14.8%, the actual capacity in sand pumped per hour was at its minimum.—Ed.)

The Advantages of Forced Blast Heating Systems for Drying Kilns.

Sir: One of our special inspectors has written to us, after a very thorough examination of premises in the South used for drying and ordering tobacco, recommending the introduction of drying kilns of the blower type as a substitute for the present method of drying by direct steam pipes. He states that manufacturers report that when once installed the process of drying by an air blast is preferable to and quicker than the steam pipe method, and he dwells particularly on the fact that in the elimination of the steam pipes from the rooms a great source of fire hazard is removed, as his inspection indicates that in no class of risks where dry rooms are used is there more universal carelessness than is found in the tobacco business. In addition to the improvement in methods, which is suggested, anything which tends materially to reduce the hazard from fire will unquestionably influence the rate which will be charged for insurance, and we write you suggesting that you call the attention of manufacturers of machinery and apparatus answering this description to the field for sales which seems to be clearly pointed out by our inspector.

You, of course, understand that we can only refer to the subject in a very general way, as the advantages of a change in system, or the reduction in the insurance rate which the change might warrant, would be determined by the conditions found in each separate property.

Yours truly,

E. L. Ballard, Asst. Secy. Continental Ins. Co.

46 Cedar St., New York city, Oct. 27, 1898.

(We believe that the general advantages of the blower system for drying kilns over the old method of drying by steam pipes directly in the kiln are now conceded by all who have given careful study to the matter. The reduction in fire hazard by this system, however, is a point which is, perhaps, not so generally understood, and the above letter is useful in calling attention to it. We may say in addition that the excess in first cost of the blower system over the old direct steam-pipe system is not so great as is sometimes claimed. With the blower system, the steam pipes are so much more efficient that a considerably smaller number of square feet of heating surface is required for a given work than is required with the direct steam system.—Ed.)

Public Improvements at New Orleans.

Sir: The City of New Orleans has just let contracts for the paving of 85,000 sq. yds. of streets, as follows: To the Compagnie Generales des Asphaltes de France (rock asphalt), at $2.49 per sq. yd.; The Ayres Land Asphalt Co., at $2.60 per sq. yd.; Belden & Seeley, or the Columbia Construction Co., of Syracuse, N. Y., the last work advertised for, at $2.10 per sq. yd. on 6-in. concrete foundation and $1.70 per sq. yd. on 4-in. concrete foundation.

We have been heretofore paying more for asphalt than any city in the county, for the reason that the Barber Asphalt Co., being the only concern in the field, enjoyed a monopoly.

The council of the City of New Orleans about a year ago passed an ordinance which prohibited the mention of any particular asphalt when bids were being advertised for. The result was that other bidders were able to enter the field and bid on every quality of asphalt. We have paid as high as $3.75 per sq. yd. for asphalt paving in the past, and up to a year ago $3.25. The low bids obtained for asphalt recently will give an impetus to street paving in this city, which is much needed, as most of our streets are paved with the square block granite or cobble stone. We would be glad to have it mentioned through the columns of your valuable paper that New Orleans contemplates letting an immense amount of street paving contracts, and would be glad to welcome all bidders.

Another work about to begin is the laying of all wires underground. The various wire companies have all their plans and specifications complete, and will begin to break ground within 30 days.

Another great work now under way is the construction of our drainage system, which will drain not only our city and lower the ground water level some 5 or 6 ft., but also drain every inch of swamp around New Orleans. The completion of this work, which will entail a cost of about seven or eight million dollars, will require some five years, and will remove the unsightly surface drainage which now prevails in our city.

A subject which is now being seriously considered by our people is the providing for the construction of a modern system of sewerage. This city granted, some years ago, a franchise to a corporation to construct a system of sewerage on plans drawn by Rudolph Hering. The company ran out of funds after building several miles of piping. The city brought suit to annul the contract or privileges. The corporation is now seeking to compromise the litigation, claiming it has plenty of funds at its back, and is willing to continue and complete construction of this sewer system. Some are in favor of a compromise and others are against; but all agree that sewerage we must have, if we desire to place this city in the rank of cities to which she belongs. The matter is now before the Sewerage Committee appointed to investigate the best measures proposed. We would therefore be glad to entertain bids, propositions or suggestions on that score.

A work of great importance about to begin is the construction by the National Government of a floating steel dry-dock for docking merchant ships and war vessels. The bids are to be opened by the Navy Department in Washington next month. Congress at its last session appropriated some $800,000 for this work.

The board of U. S. engineers appointed for that purpose have just completed their report of the survey of South West Pass at the mouth of the Mississippi. The object is to construct another jetty through South West Pass, such as was constructed through South Pass by Jas. B. Eads. This will give shipping a depth of channel at the bar of 35 ft., as compared with 26 ft. which now prevails.

Respectfully,

Sidney Story.

Equitable Building, New Orleans, Oct. 18, 1898.

Corrosion of Iron and Steel.

Sir: Your current discussion of the evidently unsettled question of the relative rate of corrosion of iron and steel reminds me that, years ago, I endeavored to secure reliable and sufficient data on the subject, to serve as a guide in practice. I found very little available material. There should be to-day much more, now that the use of steel has come to be general in all departments of engineering. The results of my researches in technical literature and reports are published in Sec. 192, Vol. II., of my "Materials of Engineering," page 328, et seq. In brief, they were.

(1) Corrosion can ordinarily only occur in the presence simultaneously, of oxygen, moisture and carbon-dioxide (Calvert).

(2) The gases of the locomotive accelerate corrosion by their peculiar acid quality, arising from their contents of sulphur-oxides; iron and steel absorbing acids somewhat greedily (Kent).

(3) Cast iron, in dilute solutions of acids, is rapidly acted upon, especially in warm water—in the flow of water of condensation from engine-condensers, for example—losing the metal, and often leaving the carbon and other matters; the piece retaining its form and general appearance unchanged, but with enormously reduced density. The metal is said by the uninformed to have been "changed to plumbago" (Calvert).

(4) Corrosion is rapidly effected with cast metal irregularly and quickly cooled in the mold, less rapidly where slowly and regularly cooled (Mallett).

(5) The rate of corrosion is ordinarily constant over long periods of time; but the removal of the rust retards oxidation as it destroys the voltaic couple composed of metal and of oxide.

(6) Hard iron, rich in combined carbon, rusts slowly. The presence of graphite or of a different quality of iron in metallic contact with it, increases the rate of oxidation—presumably by forming local voltaic couples. Hard steel rusts less rapidly than soft.

(7) Foul sea-water, as the bilge-water of a ship, corrodes iron and steel rapidly.

(8) The rate of corrosion is too variable to be stated in exact terms. The hulls of iron ships have been found to average a rate of not far from 1-16 in. in 25 years, when carefully painted. Iron roofs exposed to smoke and gases of locomotives, are sometimes ruined in three or four years.

(9) The observations of Thwaite are as follows:

The time of endurance in years may be expected to average about

$$T = W \times C L;$$

where W is the weight of metal in pounds per foot length of the member, L is its length of perimeter, inside and out, is hollow, and C is a constant, which has the following values, and the magitude of which measures the relative loss by corrosion.

Material	Water—Sea—Foul.	Water—Sea—Clear.	Water—River—Foul.	Water—River—Clear or in air.	Impure air.
Cast iron	0.0056	0.0036	0.0381	0.0113	0.0476
Wrought	.1956	.1255	.1440	.0123	.1254
Steel	.1944	.0970	.1133	.0125	.1252
Cast iron, no skin	.23	.0880	.0728	.0109	.0854
Galvanized	.09	.0359	.0371	.0048	.0199

Average for sea water: Cast iron, in contact with brass, copper or gun bronzes, 0.19 to 0.35; wrought iron, in contact with the same, 0.3 to 0.45.

This is for unpainted metal, of course. For painted iron or steel it is safe to multiply the endurance, as above, by two or more.

The precision of the above figures would seem to indicate accurate measurements, and to settle the question as respects the various metals; but, unfortunately, the quality of the steel and the influence of varying proportions of carbon, remain unmeasured, although soft and hard steels were compared with variable results. It has been assumed by the writer that the very softest steels, which contain less of the hardening elements than common iron, would oxidize more rapidly and the harder steels less rapidly, than wrought iron; while the rate of corrosion of wrought iron is subject to great variation with the variation of the chemical composition, and the mechanical structure, of its always heterogeneous mass. Graphite in cast iron, and cinder in wrought iron make with the adjacent metal rather effective voltaic combinations, and may be assumed to thus influence greatly the rate of corrosion. Very respectfully,

R. H. Thurston.

Sibley College, Cornell University, Oct. 28, 1898.

The Power of Windmills.

Sir: Mr. Hood, in his comment in your issue of Aug. 25 on my letter on the power of wind-engines, is quite right when he says that the power developed by them is a function of their load; and this phase of the problem I would have taken up there had I not, at that time, overlooked the column of Mr. Murphy's table in which he gives the loads of the wheels upon which he experimented. On correcting the proof-sheet, however, I noticed that this most important portion of the data was given, and I then rearranged my table and added two formulae, which I had devised for use when the load was known; but the letter was published before the corrected proof-sheet reached New York.

The formula

$$\text{N. HP.} = 0.0001\ D^3, \qquad (1)$$

where N. HP. is the net horse-power developed by a wind-engine, with an air current of 16 miles per hour, and D is the diameter of the wheel in feet; was based on the performance of wooden wheels and was not intended for the more efficient back-geared metal wheels now so largely used; and although it gives results which agree fairly well with the average run of metal wheels, as shown in my letter, it does so by reason of so many of these wheels being most improperly loaded, and does not give the results that should be expested of them under anything like favorable conditions,

$$\text{N. HP.} = 0.002\ D + 0.0001\ D^3 \qquad (2)$$

serves fairly well as a general formula for these latter under somewhat better conditions of load, as was also shown in my letter; although if the best judgment is displayed in proportioning the load to the size of the wheel, which seems, however, to be the rare exception, much better results may be expected from the best wheels of this class.

So extremely limited have been the data which I have found available, that I am not, at this time, able to give a general formula for all sizes of wheels and all conditions of load; from that at hand, however, I have developed the two provisional formulæ given below, which, within any reasonable limits of load, agree well with the results obtained from tests made on wheels in actual service. For back-geared metal wheels 8 ft. in diameter,

$$\text{N. HP.} = 0.001\ L - 0.023 \qquad (3)$$

while for those 12 ft. in diameter,

$$\text{N. HP.} = 0.0004\ L + 0.089 \qquad (4)$$

in which L is the load in foot-pounds per stroke, which should not, in the former, be less than 50 nor more than 100, nor in the latter less than 250 nor more than about 850.

To compare the results of these formulæ with the results of Mr. Murphy's tests, as given in his table already referred to, let us take from that table the following 8 and 12-ft. wheels, the only ones not shamefully underloaded:

No. of Wheel.	Name of Wheel.	Diameter in ft.	Load in ft. lbs.	N. HP. from tests.	N. HP. from formula.	Formula.
4	"Ideal"	8	50	.029	.027	N. HP.
6	"Gem"	8	78	.042	.055	= .001
18	"Ideal"	8	89	.070	.066	L —
5	"Aermotor"	8	95	.072	.072	.023.
13	"Aermotor"	12	330	.171	.171	
17	"Gem"	12	335	.149	.193	N. HP.
3	"Aermotor"	12	415	.207	.205	=
19	"Gem"	12	450	.162	.219	.0004
7	"Aermotor"	12	462	.221	.224	L +
2	"Mogul"	12	536	.260	.253	.039.
11	"Ideal"	12	844	.325	.377	

From the above it is seen that the results of the formulæ agree closely with those of the tests, the only discrepancy of any importance occurring with the "Gem" wheels, the tests of which show results uniformly low.

It is because of this most important condition of load not ordinarily being taken into account that the results of tests nearly always present such an appearance of confusion as to give one, not familiar with the subject, an idea that to experiment is to waste time and to attempt to discover laws is folly. It will, however, be seen from the above table that, when properly arranged, these data present a most regular appearance, and show results so consistent as to surprise, perhaps, many to whom the subject is not new.

Due to an improper load, many superior wheels have, without doubt, been condemned, while a neighboring wheel of inferior make, but more properly loaded, receives undue praise. Due also to this is the fact that large wheels often perform less work than smaller ones of no better or inferior makes. This is shown in the case of Nos. 12 and 11 of Mr. Murphy's table. Here No. 12, a 14-ft. wheel of high grade, is given a load so small that it develops but 0.125 HP., while No.11, a 12-ft. wheel of the same make, but with a better proportioned load, develops 0.325 HP.

A series of experiments much more extended than any so far attempted, and on somewhat different lines, should be made, not only because it is a subject of considerable interest, but because it is one that is growing to be of greatest practical importance, as upon the successful installation of small pumping plants, cheap in first cost and economical in operation and maintenance, depends the success or failure of great numbers of agriculturists scattered over a vast area of our country.

M. Fargusson.

Southport, N. C., Aug. 29, 1898.

(After receiving the above letter we received from Mr. E. C. Murphy a letter criticising some features of Mr. Fargusson's first letter (Eng. News, Aug. 4), which were covered by the letter above. We, therefore, submitted a proof of the above letter to Mr. Murphy, who continues the discussion with the following letter.—Ed.):

Sir: I am glad to learn from Mr. Fargusson's second letter that he appreciates the fact that the load on a windmill should be taken into account in computing its power. In his first letter he neglects the effect of load, and has to throw out of account some of the results of mills that I have tested, because "they are not consistent with one another." In his second letter he takes into account the load factor and finds that "they show results so consistent as to surprise perhaps many to whom the subject is not new."

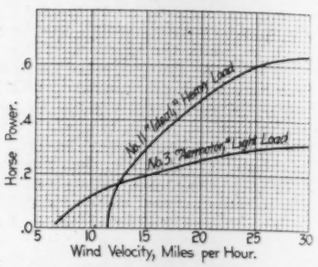
The effect of this load-factor on the power of a windmill was first published in the "Kansas University Quarterly," of October, 1895; it is illustrated by the case of a 12-ft. "power" mill in Engineering News of Aug. 19, 1897, and is quite fully discussed in "Water Supply and Irrigation Paper," No. 8.

Mr. Fargusson mentions the need of a more extended series of tests of windmills. The U. S. Geological Survey is in possession of the results of two seasons' tests in addition to those in Paper No. 8, by the writer and will publish them in due time; these cover all sizes of steel mills and several sizes of wooden ones.)They include power as well as pumping mills.

In regard to Mr. Fargusson's formula for the net power of a windmill, it does not give the total net power of a mill. The efficiency of the pump and well should be taken into account. The total power can be best found from power mills.

Prof. O. P. Hood in his remarks on Mr. Fargusson's formula (Eng. News, Aug. 25) makes a statement that may be misleading. He speaks of Mr. F. H. King getting results very different from those that I have gotten. Mr. King found the brake power of a 16-ft. mill to be 1.08 HP. in a 16-mile wind. I found the pumping power, expressed in useful work done by the mill and pump, of a 16-ft. mill No. 9, to be .433-HP. in a 16-mile mind. The loads on the mills are not given, or the make of mill, hence a just comparison of the actual power of the two mills cannot be made.

Professor Hood also gives some figures showing the useful work done by a "typical" 10-ft. mill and pump per month, in the vicinity of Manhattan, Kan. He does not state what kind of a mill this typical mill is, whether wood or steel, back geared or working direct stroke, or what the load on the mill. Permit me to give the useful work of two 12-ft. steel, back-geared pumping mills, in the vicinity of Dodge City, Kan., for the six irrigating months —April to September. The data for this purpose is taken from "Water Supply and Irrigation," Paper No. 8. The two mills selected are a 12-ft. aeromotor No. 3, and a 12-ft. Ideal No. 11. The former being a lightly loaded mill, 413 ft.-lbs. per stroke of pump, and the latter heavily loaded, 844 ft.-lbs. per stroke, the effect of difference in loading will be seen.



Horse-power Curves of Two 12-ft. Windmills, Showing Influence of Load.

The useful work in horse-power done by these mills in different wind velocities is shown in Fig. 1. No. 3 being lightly loaded will start in a 7-mile wind; No. 11 requires an 11½-mile wind to start it, but gives more power than No. 3 for all velocities above 12½ miles per hour.

The mean monthly wind movement at Dodge City for seven years, for the months, April to September, is given in Table I. The numbers in this table show the mean number of hours in each month that the wind velocity was 0 to 5 miles per hour, 6 to 10 miles per hour, etc. Thus for the month of April—if the number of hours that the wind velocity was 0 to 5 miles per hour for the seven years be added and the sum divided by 7, the quotient is the first number given in column 2.

From this table we see that at this place, for these six irrigating months, there are 140 hours per month when the wind velocity is 0 to 5 miles; 198 hours per month when it is 6 to 10 miles; 157 hours when it is 10 to 15; 109 when it is 16 to 20; 72 when it is 21 to 25; 34 when it is 26 to 30; and 22 hours when it is 31 and upwards miles per hour. The wind velocity here is 11 and upwards miles per hour for 54% of the time.

By a study of the diagrams and table we see that during the 140 hours when the wind velocity is 0 to 5 miles per hour neither of the mills will do any useful work. Mill No. 3 will start in a 7-mile wind, and will run about four-fifths, or 158 hours, out of the 198 hours when wind velocity is 6 to 10 miles per hour. This mill will run for all higher velocities. No. 11 requires an 11½ miles wind to start it, and will run for about 141 hours out of the 157 hours when wind velocity is 11 to 15 miles—it will run for all higher velocities. No. 3 will run—if in the wind—about 75% of the time, and No. 11 about 51% of the time.

The useful work done by each mill in a mean month is given in Table II. Columns 2 and 5 give the number of hours during the mean month that each mill was running when the wind velocity was as given in column 1. The power, given in columns 3 and 6, is the horse-power taken from the diagrams Fig. 1 for the mean of the corresponding velocities in column 1. The useful work—columns 4 and 7—in ft.-lbs. is found by multiplying the power by 1,980,000 to reduce to ft.-lbs. per hour, and this by the number of hours in columns 2 or 5, as the case may be, to get the work for the particular time. The total useful work done during the mean month is 197,010,000 for No. 3, and 289,476,000 for No. 11. If we divide the first of these by 73, and the second by 75.3, these being the number of sq. ft. in the respective sail areas, we have 2,700,000 ft.-lbs. for No. 3, and 3,844,300 ft.-lbs. for No. 11; as the useful work per sq. ft. of sail area for the mean month. The former of these is only 70% of the latter, hence No. 3 lightly loaded and running about 75% of the time does only

TABLE I.—Mean Wind Movement at Dodge City, Kan., for the Seven Years 1889 to 1895.

Months.	Velocity, miles per hour. 0 to 5.	6 to 10.	11 to 15.	16 to 20.	21 to 25.	26 to 30.	31 and upwrds
April	116	175	157	113	76	43	40
May	116	195	168	120	74	39	32
June	120	187	139	111	86	49	28
July	144	218	176	117	57	23	9
August	178	230	152	99	62	18	5
September	166	182	152	93	75	34	18
Sums	840	1,187	944	653	430	206	132
Means	140	198	157	109	72	34	22

TABLE II.—Total Useful Work Done by Mills Shown in Fig. 1. in an Average Month.

Velocity wind, miles per hour.	Mills. No. 3. Hrs.	No. 3. Power.	No. 3. Useful work.	Mills. No. 11. Hrs.	No. 11. Power.	No. 11. Useful work.
6 to 10	158	0.067	20,988,000	0	0.0	.....
11 " 15	157	.168	52,272,000	141	0.19	53,064,000
16 " 20	109	.230	49,698,000	109	.40	86,328,000
21 " 25	72	.277	39,402,000	72	.56	79,794,000
26 " 30	34	.308	20,790,000	34	.63	42,372,000
31 & upwads.	22	.320	13,860,000	22	.84	27,918,000
Total			197,010,000			289,476,000

7-10 as much work as No. 11, which runs only about 51% of the time.

It must be remembered that this is not a comparison of the power of these mills. These figures show the actual amount of useful work these mills are doing per month, each with its own conditions of well, pump, etc. There must of course, be a reservoir to store the water pumped, so that the mill can be at work whenever there is wind enough to run it.

It must be remembered, too, that the wind velocity at Dodge City, Kan., is somewhat greater during July and August than in Eastern Kansas, and many other parts of the United States. It is quite possible that if these two mills were placed, say in Eastern Kansas, the other conditions of loads, wells, pumps, etc., remaining the same, No. 3 might do more work in some months than No. 11. The load on the mill should be suited to the wind velocity of the locality where the mill is to be used.

Respectfully, E. C. Murphy.

Lawrence, Kan., Sept. 10, 1898.

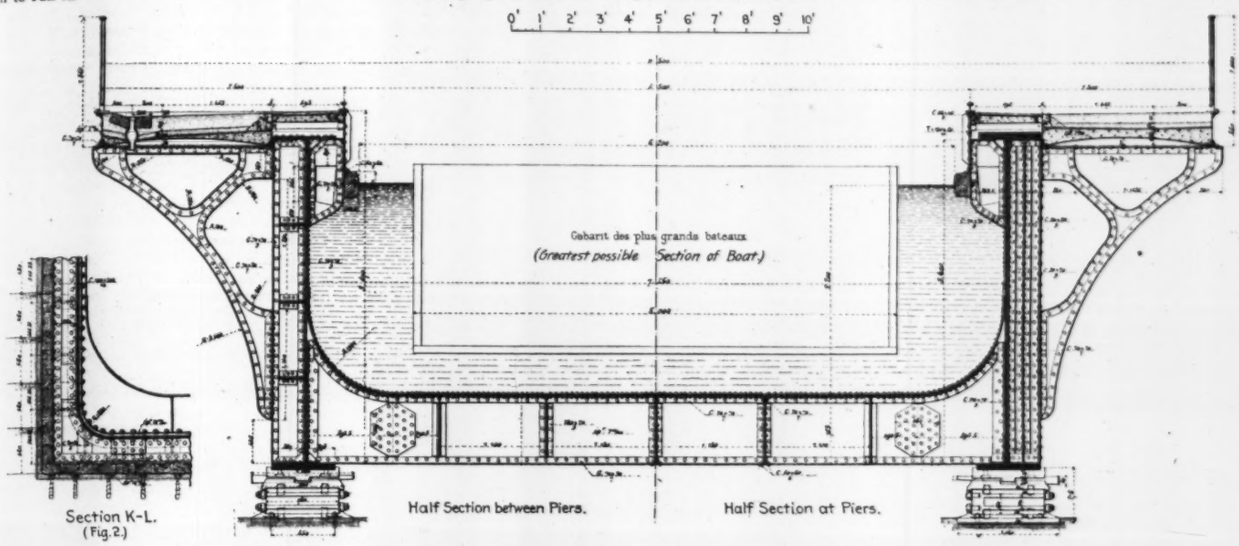

0' 1' 2' 3' 4' 5' 6' 7' 8' 9' 10'
Gabarit des plus grands bateaux
(Greatest possible Section of Boat.)
Section K-L.
(Fig. 2.)
Half Section between Piers.
Half Section at Piers.

FIG 1. TRANSVERSE SECTION OF STEEL TROUGH OF BRIARE CANAL AQUEDUCT, BRIARE, FRANCE.

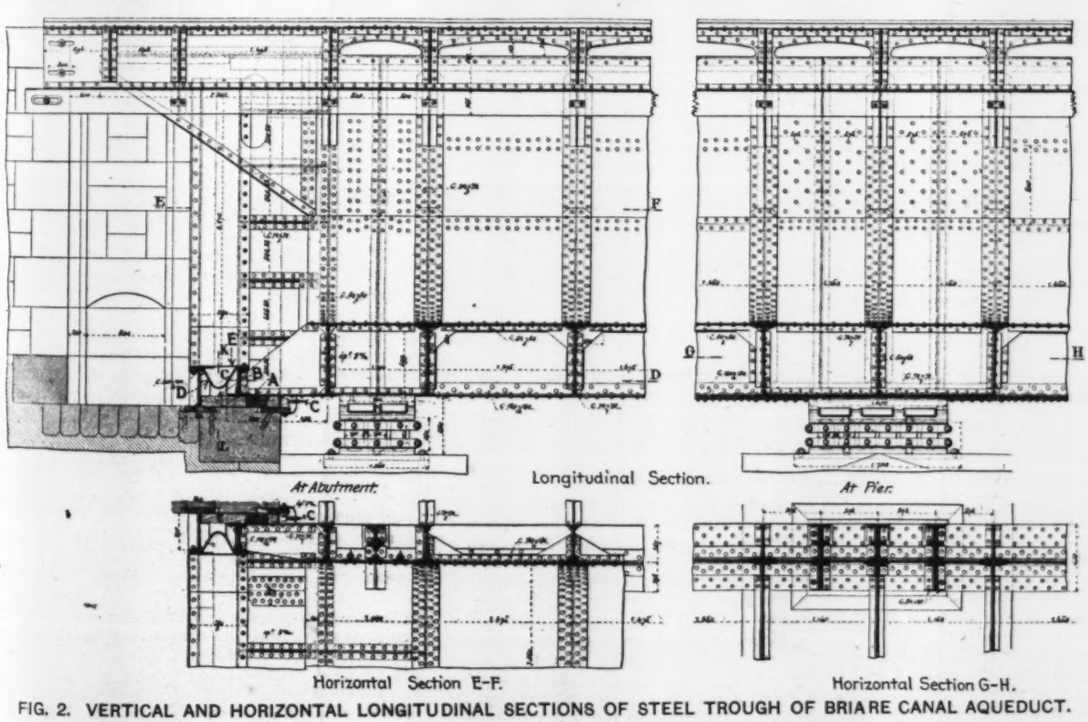


FIG. 2. VERTICAL AND HORIZONTAL LONGITUDINAL SECTIONS OF STEEL TROUGH OF BRIARE CANAL AQUEDUCT.

STEEL CANAL AQUEDUCT AT BRIARE, FRANCE.

The Briare aqueduct carries the new level recently built to connect the Loire and the Briare canals across the River Loire, near the town of Briare, France. It is 662,687 m. (2,173.6 ft.) long and 6.2 m. (20⅓ ft.) in clear width, with a depth of water of 2.2 m. (7.216 ft.), and consists of a continuous trough-shaped steel tank carried on masonry piers. Altogether there are 14 piers and 3 abutments carrying 15 spans of steel trunk 40 m. (131.2 ft.) long, and one span 12,150 m. (39.85 ft.) long. The 15 main spans cross the river Loire proper, and the single short span passes over the old line of the Loire canal, which runs parallel and close to the right bank of the river at this point. Fig. 1 is a transverse section, and Fig. 2 is a part longitudinal section of the steel trunk showing its construction and the method of supporting it on the masonry. So far as we know, this is the longest steel trough canal aqueduct ever built.

The material of the river bed at the point of crossing was a calcareous earth with interspersed modulus of chalk, below which at a depth of from 5 m. to 8 m. (16.4 ft. to 26.24 ft.) was a homogeneous calcareous tuff suitable for a foundation bed. Upon this solid layer the piers were founded, steel caissons sunk by compressed air being used to reach the proper depth. Except for the number of caissons sunk and the amount of masonry to be built this foundation work calls for no especial mention.

The more interesting features of the work are connected with the steel trough construction. This is shown quite clearly in Figs. 1 and 2. First of all the question arose whether the trough should be made continuous from one end of the aqueduct to the other, or whether each span should be independent. The continuous structure was cheaper, but in case of settlement of the foundations it would involve serious difficulties from racking strains. These difficulties would be largely avoided by constructing the spans independent, but, on the other hand, the cost would be far greater. Considering the excellent foundation bed and the very small likelihood of settlement, it was finally decided to make the trough a continuous structure. It was, therefore, fixed to pier No. 8, counting from the left bank of the river, and mounted on movable bearings on all the other piers, and at the abutments where properly-designed recesses in the masonry allow free expansion and contraction.

Referring to Figs. 1 and 2, it will be seen that the main supporting members of the trunk are the two parallel I-beams or plate girders which form its sides. These girders are 3.4 m. (11,152 ft.) deep and are spaced 7,259 m. (23.8 ft.) apart c. to c. Riveted to these girders is a bottom framing of transverse and longitudinal girders carrying the steel plate flooring or bottom of the trough. Brackets attached to the outside of the main plate girders carry the tow paths, and similar brackets on the inside support the footpath and fender timbers. Altogether the metal trunk weighs 6,935 kilos. per lineal meter without water, or 22,535 kilos. per lineal meter when filled to the normal depth of 2.2 m. of water for navigation. The total amount of steel in the structure is 3,076,647 kilos. (6,768,623 lbs.).

The manner in which the expansion and con-

traction of the steel trough is provided for is about the only detail not clearly explained by the drawings. Between the limits of temperature of — 20° and + 50° C, the movement at one side of the anchor pier is 216 mm., and upon the other side 246 mm. To provide for these movements the steel trough slides back and forth like a piston in recesses in the end abutments. This sliding joint is shown by Fig. 2, where A is a compressible packing held in place by the timber lagging B and the screws C; D is a sheet of rubber joining the ends of the fixed and movable troughs; and E E are sliding steel plates protruding over the rubber joint.

The total cost of the steel trunk, including the guard gates at each end and miscellaneous constructions, was 1,243,028 fr., or about $248,605. The cost of the substructure was 1,563,689 fr., or about $312,737, making the total cost about $561,342. For the information from which this description has been prepared we are indebted to a paper by Mr. Mazoyer, in "Annales des Ponts et Chausses," for July, 1898.

GEORGE E. WARING, JR.

Col. George E. Waring, Jr., one of the best known sanitarians of the country, died at his home in New York city on Oct. 29, from yellow fever, contracted while acting as special commissioner of the United States Government to investigate the sanitary condition of Havana, with the view of devising a system of sanitation which would render the Cuban capital safe for occupation by the American troops. Col. Waring had returned to New York from his duties at Havana only five days previous to his death. At the time he landed he was suffering from what was supposed to be malarial fever, and it was not until two days later that the disease was correctly diagnosed as yellow fever, when a thorough quarantine was established over the patient and his family. The body was cremated in accordance with the personal wishes of Col. Waring when alive and conforming to the regulations of the New York Board of Health in cases of death from malignant infectious diseases.

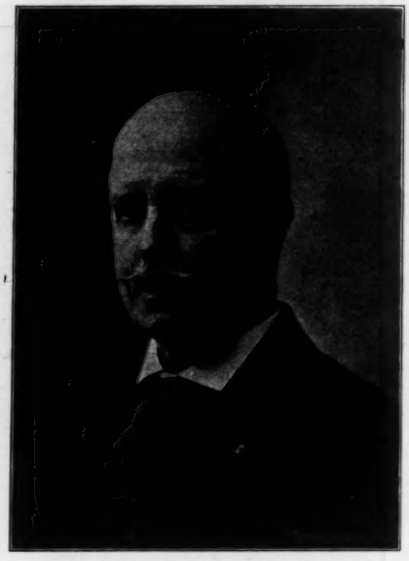
Geo. E. Waring was born at Poundridge, Westchester Co., New York, on July 4, 1833, and received his education at Poughkeepsie, N. Y. He also took a course in agriculture and agricultural chemistry under the late Prof. James J. Mapes. In 1855 his lectures on agricultural subjects attracted the attention of Horace Greeley, who made the young student the manager of his famous experimental farm at Chappaqua, N. Y. Mr. Waring remained the manager of the Greeley farm for three years, when, in 1857, he was appointed drainage engineer of Central Park, New York city. This position he held four years, during which time he designed the present drainage system of the park, and he left it only to go to the front as Major of the Garibaldi Hussars at the outbreak of the Civil War. Later Major Waring raised a squadron of cavalry in New York city which was known as the Fremont Hussars. Afterwards transferred to the Department of the Southwest, he was appointed Colonel of the 4th Missouri Cavalry.

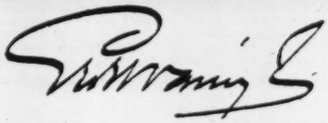
In 1867 Col. Waring established himself in Newport, R. I., as manager of the Ogden farm, where he lived for ten years, conducting, in addition to his work on the farm, a general consulting and advisory practice in drainage and sanitation for dwellings and institutions. His name first became prominent in city sanitation and sewerage when, in 1878, he designed and constructed at Memphis, Tenn., the well-known "separate system" of sewerage which has since been inseparably associated with his name, and which he has introduced into various other American cities.

Without doubt, however, Col. Waring gained his greatest reputation, in the mind of the general public at least, by his work as Commissioner of Street Cleaning in New York city, to which position he was appointed Dec. 30, 1894. The revolution accomplished in the work of cleaning the streets of the metropolis by the systematic and business-like methods introduced by the new Commissioner are of too recent knowledge to engineers to require description here. The change in the politics of the city administration, however, threw Col. Waring out of his position on Jan. 1, 1898, although the system which he had established still remains in force in the department which he put on such an efficient basis.

When a few weeks ago it was determined to send a Government Commission to Cuba for the purpose of selecting camp sites for troops and making provision for sanitary improvements in the principal cities of the island, Col. Waring was appointed at its head. He was appointed by President McKinley on Oct. 2, and he sailed for Havana shortly afterward. In that city he spent the next few weeks making a special study of the sanitary conditions with the view of suggesting plans for perfecting them. Having completed his studies, he had returned home to submit his report to the Government authorities, when the illness which caused his death overtook him.

Col. Waring was a member of a number of sci-





entific and technical societies, including the Institution of Civil Engineers, the Sanitary Institute of Great Britain, and the Royal Institute of Engineers of Holland, and he also belonged to the Century Club, Players' Club and the City Club, and was President of the last organization. Besides his well-known writings on sewerage, street cleaning and sanitation, Col. Waring wrote many admirable sketches of travel for the more prominent magazines. A widow and one son survive him.

THE TONNAGE AND DISPLACEMENT OF SHIPS.

At the present time, when naval matters are a source of great interest to the general public, one continually finds the terms "displacement" and "tonnage" improperly used, both in the daily press and in common speech. The confusion between the terms would not occur if their meaning were understood. "Displacement" refers to the quantity of liquid displaced by the immersed hull of the ship; and "tonnage" to the freight-carrying capacity of the ship determined by certain rules of measurement.

The displacement of a vessel is the entire weight of the hull with all its contents, according to the well-known law of hydrostatics; that a floating body displaces a weight of fluid just equal to its own weight. A ship sinks in the water to such a level that the pressure of the fluid displaced exactly counterbalances the weight of the ship.

Tonnage is figured by what is known as the Moorsom system; originally adopted by England, in 1836, and since 1865 officially recognized by all maritime nations, with some unimportant differences in the methods of measurement. The "register ton" is 100 cu. ft. of internal volume; and a ship having 100,000 cu. ft. of internal space, within the points of measurement prescribed in the English Merchants' Shipping Acts of 1854 and 1867, is said to be "1,000 tons register." This cubic ton of 100 cu. ft. now forms the unit of assessment for dock, harbor, towage and other dues. Previous to 1836 the tonnage of British ships was found by multiplying the square of the breadth by the inboard length and dividing by 94. This "old measurement," though far from exact, is still used to some extent in measuring pleasure yachts, etc. Under this old system the depth of the hold was taken as being the same as the beam; and the interest of ship-owners caused them to build ships of narrow beam and increased depth, with resultant unseaworthiness and poor sailing qualities. Abuses of this kind and the imperfections of the old system of measurement brought about the adoption of the new law of 1836, and this law was simply an elaboration of the theorem of Isaac Newton for measuring spaces bounded by irregular curves.

The Moorsom system of 1836, amended and elaborated by later enactments, provides for actual measurements of depth made at certain intervals, with the number of these intervals depending on the length of the tonnage-deck of the vessel. (This tonnage-deck is the upper deck on ships with less than three decks, and the second deck, from below, if there are three or more decks.) Transverse areas are then computed at these points in feet and decimals of feet; these transverse areas, after being multiplied by certain numbers, according to the class of ship, are added together, multiplied by one-third the common distance between the areas, and divided by 100. To obtain the "gross registered tonnage," there must be added to this the tonnage of all spaces above the tonnage-deck, the poop, deck-houses, etc. This is obtained by multiplying the horizontal area by the mean height and dividing by 100, as before.

In steamships, the space occupied by the engine-room, and the screw-shaft space considered as part of the engine-room, is to be deducted from the gross tonnage. The Merchants' Shipping Act of 1867 especially refers to the crew-space, and requires that owners provide proper accommodations for the crew before the space they occupy on a ship can be deducted from gross tonnage in estimating dues of various kinds. In freighting ships, 40 cu. ft. of merchandise is considered a ton, unless that bulk should weigh more than 2,000 lbs., in which case the freight is charged for by weight.

NOTES FROM THE ENGINEERING SCHOOLS.

Cornell University.—The annual report of President Schurman says that during the last year attendance has been greater than ever before, and, owing to the great advance recently made in the standards of admission to nearly all courses, a striking improvement in scholarship has been wrought. The "median age" of the freshmen has decreased from 19 years 11 months in 1895-6 to 19 years 7 months in 1897-8, notwithstanding the increased requirements for admission, which indicates that the high schools of the country are improving.

Under the direction of Profs. Fernow and Roth there have been arranged a full four-year course leading to a degree of Bachelor of the Science of Forestry, a one-year special course, and a one-term synoptical course. The four-year course is planned to give a thorough knowledge of all branches of the profession and to prepare men to manage and administer forest estates for private owners or for the state or national government, and also to teach the profession in the colleges, which are likely in the near future to establish chairs of forestry science and practice. This course comprises in its first two years the preparatory studies of mathematics, natural science, engineering, political economy, etc., its last two years being devoted to the purely professional subjects. The one-year special course is planned for farmers, lumbermen, and others not desiring a general scientific training, but wishing to acquire such technical and practical knowledge of

forestry as will enable them to manage more intelligently and economically their own woodlands. Finally, the one-term synoptical course will meet the requirements of students of political economy and others wishing to make a brief survey of the subject of forestry as a matter of general education.

THE GERMAN CANAL BILL which is to be introduced into the Reichstag during the coming session provides for the expenditure of 400,000,000 marks on canals and river improvements as follows: Midland Canal, 192,000,000 marks; Dortmund-Rhine Canal, 68,000,000 marks; 50,000,000 marks for water sheds, etc., in the Oder district; 40,000,000 marks for the Berlin-Stettin Ship Canal, and 20,000,000 marks for the improvement of the Weser River. When the scheme is executed it is announced that the main waterways of Prussia will be connected from the eastern extremity of the Empire to the harbors of the German Ocean.

SEWAGE DISPOSAL AT TORONTO, ONT., is the subject of a report by Mr. C. H. Rust, Cy. Engr. He recommends the construction of intercepting sewers, on the general plan proposed by Messrs. Hering & Gray, in 1889, and the provision of purification works in addition. The cost of the intercepting sewers is estimated at $820,000. Final disposal works are estimated at $910,000 for intermittent filtration, and $720,000 for chemical precipitation, with filtration of the effluent. The annual charges for filtration would be less than for precipitation. Before deciding on a purification system, Mr. Rust advises the employment of a consulting engineer.

A DECISION OF THE SUPREME COURT of Illinois recently rendered gives the City Council of Chicago, Ill., the right to insist upon compensation for street railway franchises. The decision is a sweeping one, as it established the right of compensation without any limitations. The decision was given in the appeal of the Chicago General Ry. Co. against a judgment of $2,250 given the city. The ordinance under which the railway operates imposes an annual fee of $500 per mile of track and the company refused to pay this tax.

CHEAPER ELECTRICITY IN NEW YORK CITY will without doubt follow the cut in rates just announced by the United Electric Light & Power Co., of that city. About a year ago the Edison company introduced a schedule which had as its maximum one cent per 16-c. p. lamp per hour. Discounts were given to customers burning their lamps for long periods, and it was claimed that this made the cost in some cases less than ½-ct. per lamp per hour. Small customers were required to pay one cent. The schedule just announced by the United Electric Light & Power Co. starts with a maximum of ¾-ct. per lamp hour, and grades down, according to the amount of current used and the time lamps are burned, to a minimum of 1-3-ct. per lamp per hour.

TO HOLD ITS RIGHTS ON THE CANADIAN SIDE of Niagara Falls the Canadian Niagara Power Co., which is controlled by the Niagara Falls Power Co., is required to pay an annual rental of $25,000 to the commissioners of Queen Victoria Niagara Falls Park. This agreement was entered into in April, 1891, and further provides that the company shall have 10,000 developed horse power and water connections for 25,000-HP. by Nov. 1, 1898. Some months ago an extension of time was asked and allowed and the company was permitted to install two 500-HP. generators in the station of the Niagara Falls Park & River Ry. It has been reported in Canada that the company would voluntarily forfeit its rights, but on Oct. 18 the semi-annual rental of $12,500 was forthcoming, thus proving the company's intention to hold its rights to develope power on the Canadian side.

AN ACETYLENE GAS LIGHTING PLANT has been installed at Milford, Pa., according to "Heating and Ventilation." The plant, like the village, is small. At present there are only some 3,000 ft. of mains, 3 ins. in diameter, or less, within the village, and one or two extensions outside. There are five generators and a gasometer, located in a small building. The generator is of the Troubetzkoy type, made by the Mechanical Engineering Construction Co., 63 Fifth Ave., New York city.

NOISELESS MANHOLE COVERS, as they are styled by their makers, are in use in Philadelphia, and in some other cities, we believe. The main features of the covers are to have as large a part of their area as possible composed of the same material as that used for paving the street in which they are placed and the keeping of the street and cover at the same level. Thus, in asphalted streets, where they are principally used, the whole top of the cover, except the rim, is filled with asphalt. Further particulars regarding these covers may be obtained from A. L. Greger & Co., 315 North Broad St., Pa., and the Sanitary Engineering Co., Girard Building, Pa.

STEEL WAGON TRACKS FOR COMMMON ROADS at Scranton, Pa., are under discussion. It is reported that the Abington Turnpike Road Co., through W. W. Watson, has stated that it would lay a half-mile of the track as an experiment.

A MEMORIAL TO RICHARD M. HUNT, the late architect, was unveiled in New York city on Oct. 31. This memorial is a semi-circular granite and marble bench set into the wall of Central Park, on Fifth Ave., near 71st St. It was erected by a committee representing the various architectural, artistic and literary organizations that recognized the efforts of Mr. Hunt to raise the standards of American architecture.

AMERICAN EXPORTS OF WIRE NAILS are commented upon in the "British Iron and Coal Trades Review." This report from the United States to Europe has grown from 1,547,078 lbs. in 1888 to 22,894,099 lbs. in the fiscal year 1898. The growth in trade is exceptionally rapid in the last two or three years. In 1895 the exportations were 4,367,267 lbs.; in 1896, 8,031,927 lbs., and in 1898, 22,894,099 lbs. These American wire nails go to Germany, France, Belgium, Netherlands, the United Kingdom, Canada, Central America, West Indies, all South America, China, Japan, Asiatic Russia, Australasia, and British and Portuguese Africa.

COMPRESSED PEAT FUEL is being made by the Canadian Peat Fuel Co., of Welland, Ontario, under the patents of Mr. A. A. Dickson, of Toronto. The peat is dried in the air and then disintegrated in a breaker revolving at a high speed, and is thus reduced to a powder without unduly breaking up the fiber. The peat powder is withdrawn from the breaker by an exhaust fan into a large hopper, and from this it descends into a machine which compresses it into cylinders 2 ins. diameter and 2 ins. long, under a pressure of 30 tons. It is thus reduced to one-sixth the bulk of the raw material. The machine has a capacity of 1½ tons of compressed peat per hour. This fuel is claimed to be non-friable and weatherproof, owing to its solidity and the external glaze imparted by friction in the forming-dies. The inherent moisture of the peat is reduced to 12%, and the weight of the fuel is 83 lbs. per cu. ft., as compared with 73 lbs. for bituminous coal and 93 lbs. for anthracite coal. No prices are quoted, but the fuel is said to have been successfully tested in competition with coal.

A MINING AND INDUSTRIAL EXPOSITION will be held at Coolgardie, Australia, beginning March 21, 1899, and continuing at least two months, in which American manufacturers and mining interests are especially invited to take part. It is stated that special scope will be afforded for the exhibition of mining, timber and agricultural machinery, gold saving appliances, electric lighting apparatus, bicycles, household fittings and food specialties. The British Embassy at Washington, D. C., can furnish information concerning the exposition.

THE SALT MINES OF WIELICZKA, near Cracow, Poland, were mentioned in 1044 and have been worked since 1240. The first map of the mines was made in 1638 by Martin German, a Swedish mine surveyor. The eight shafts now in existence are from 207 to 985 ft. deep and the length of the levels now open is 345,000 ft., with 115,500 ft. of underground tram-lines. Between 1772 and 1892 about 3,000,000 cu. yds. have been excavated for the extraction of salt. Machine drills are now used and compressed powder is employed in blasting; about 1.187 lbs. of powder are used per ton of salt produced. The present levels are 7¼ ft. high by 6¼ ft. wide.

BOOK REVIEWS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. Proceedings of the 5th Annual Meeting, held in Toronto, Ont., Aug. 16-18, 1897. Vol. V. Cloth, 8vo.; pp. 337.

The Society for the Promotion of Engineering Education has now grown to a membership of 226. It consists chiefly of professors in engineering schools, but contains also a few engineers in private practice. It meets once a year, the meetings being held in the same place as the annual meeting of the American Association for Advancement of Science, but a few days earlier, so that members may conveniently attend the meetings of both societies. The following is a list of the principal papers and discussions in the present volume: "Engineering Laboratory Courses," by R. C. Carpenter; "A Course of Study in Electrical Engineering," R. B. Owens; "At What Point Should Students Engage in Specific Research," C. D. Marx; "Uniformity of Symbols in Engineering Text Books, Report of Committees, Methods of Teaching," W. H. P. Creighton; "Elective Studies in the Regular Engineering Courses," H. S. Munroe; "The Calculus for Engineering Students," F. W. McNair; "Chemical Engineering," J. M. Ordway; "The Teaching of Machine Design," J. J. Flather; "The Efficiency of Technical as Compared with Literary Training," T. C. Mendenhall; "A Course in French and German for Engineers," A. N. Van Daell; "The Extent to Which Metallurgy Should be Taught in Engineering Courses," M. E. Cooley; "Manual Training for Artisans," C. M. Woodward; "The Manual Training High School," T. W. Mather; "The Agricultural College in Its Relation to Engineering Education," C. S. Murkland; "Graduation Theses," I. O. Baker.

THE REPLY OF STATE ENGINEER ADAMS TO THE CANAL INVESTIGATING COMMISSION.

In our issue of Aug. 11 we published an abstract of the report presented by the Commission appointed by Governor Black to investigate the work of enlarging the Erie, Champlain and Oswego canals. A reply to that report and to the various charges made therein was made by State Engineer Campbell W. Adams, under date of Sept. 12, and we have just received a copy of this reply, a document of 89 printed pages. Inasmuch as the report of the Commission has been given publicity in our columns, we deem it only fair to present as fully as our space will permit the other side of the case as given in Mr. Adams' statement.

Preliminary Estimates of the Cost of the Work.

At the outset Mr. Adams points out the undoubted fact that the State Engineer's Department was not responsible for the fixing of the canal appropriation of 1895 at $9,000,000. The estimate of that department submitted to the Constitutional Convention of 1894, was $11,573,000, and this was specifically stated to be little more than a rough guess, since no surveys had been made or were available by which the cost of the contemplated improvement could be determined. Further, it was made on the assumption that 1 ft. could be dug from the bottom and 1 ft. placed on the banks without disturbing existing vertical or slope walls, an assumption which has proved wide of the mark. The fixing of the canal appropriation at $9,000,000, and, in fact, the drafting of the canal improvement law, was done by the Executive Canal Committee, which fixed on $9,000,000 for no better reason than that it was the largest round sum short of one represented by eight figures, and it was feared that if a larger sum were asked for the appropriation might be defeated.

Immediately after the result of the election was known, a force of engineers was made up, and set to work on the preliminary surveys and estimates. Some delay was encountered in getting sufficient men from the Civil Service Commission, and the force thus obtained was, Mr. Adams says, somewhat deficient in experience, but otherwise "unquestionably equal in personnel to any corps of equal size ever organized." This preliminary survey was cut somewhat short in deference to popular criticism of the amount of expenditures on engineering work. The estimates when finally made up in November, 1896, showed that the total cost of the improvement would be in the neighborhood of $15,000,000. This information was given to the Executive Canal Committee, but appears to have been withheld by them from the public. The State Engineer believed that these estimates included a great deal of work which, though badly needed, could possibly be deferred till further appropriations, and the estimates were returned to the engineers in the field with instructions to cut out all work that could possibly be held; this attempt to bring the work within the limits of the appropriation resulted in failure; but the State Engineer maintains it was conscientiously and honestly made. In any event the law was mandatory, and the engineers were compelled to proceed with the work, whether the funds in hand were sufficient to complete it or not.

The Specifications.

Messrs. North and Cooley, the Consulting Engineers to the Commission, criticised the specifications for the work, which were so drawn as to provide for payments to the contractor for each separate item of work done. Messrs. Cooley and North think it would have been better to have made fewer items of the work, thus lessening the amount of measurement and supervision necessary on the part of the engineers in charge. In reply Mr. Adams states that the specifications for the work were prepared as the result of ex-

tended conference between the State Engineer's office and all the division and resident engineers employed on the work, men who had been on the State canals from 3 to 30 years. He continues as follows:

1. The engineers suggest that this type of specification is somewhat antiquated. On the other hand it is believed that the great bulk of the public work in this country today is based on similar specifications, that is, a specification providing a separate rate of compensation for each of the units comprising the work, and it is still believed to be the best for this especial purpose for this reason;—it does not ask either the State or the contractor to insure against conditions which can not be foreseen, and, on the contrary, it provides for what it supposed to be an equitable compensation for the actual amount of work done—no more and no less.

If the State asks the contractors to name a price for completed work to be done under risky conditions, as most of this work is done, the inevitable result would be higher prices. On the other hand, if the State asked for such prices and attempted to define the conditions in advance, and it was afterward found that those conditions developed otherwise than as stated, the contractor would surely claim additional allowance, and experience shows that the courts have and will allow such claims under such conditions whether the engineers do or not.

Moreover, if these conditions prove to be less arduous than as defined, experience shows that the State would be unable to effect any saving. It is a rule that does not work both ways. Except in very rare cases, the prices for the work under these specifications are too low. The commission agrees that they "are as low as could reasonably be expected." They also admit that the resulting work is superior to similar work heretofore done on the canals. Witness the paradox: Poor specifications produce good work at low prices!

Considerable space is devoted to this subject, and Mr. Adams gives in detail his reasons for believing that it is better, in building vertical or slope walls, for example, to measure up and pay the contractor for all the work he does under the separate heads of excavation, sheet piling, masonry, back-filling, lining and embankment.

Earth and Rock Classification.

A large part of the Commission's report was devoted to a detailed account of the cases where contractors have been paid for material excavated as rock which should properly have been classified as earth. Mr. Adams is emphatic in his denial that the material in question was improperly classified. To combat the popular idea that a large part of the money on the canals has been spent in digging earth which has been paid for as rock, Mr. Adams presents figures in substantial harmony with some contained in the Commission's report, which show that the total amount of material other than solid ledge rock which has been excavated and paid for at rock prices amounts to 298,345 cu. yds. The average price for rock excavation was $1 on the middle division, $1.24 on the Eastern and $1.69 on the Western. Up to May 1, 1898, the total amount of material excavated was 6,060,097 cu. yds., of which about 731,000 had been returned as rock.

By the terms of the specification, earth excavation was declared to:

Include removal of all clay, loam, sand, quicksand, gravel, pure, mixed or combined; boulders measuring less than one-half a cubic yard, dry vertical wall, slope wall, paving, docking and cribs, timber foundation of all descriptions and hard pan or soft or rotten rock which, in the opinion of the resident engineer, can be plowed.

Dry excavation of rock was defined to

Include the removal of all solid or ledge rock and hard pan which, in the opinion of the resident engineer, cannot be plowed, and all boulders measuring ½ cu. yd. or more.

Mr. Adams' reply to the charges of the Commission that a large amount of earth was improperly classified as rock is in general a specific denial. He avers that the plowing tests called for were faithfully made, and that records kept by the engineers to determine the cost to the contractors of excavating the hardpan classified as rock show that the cost was about the same as that of actual rock excavation. Concerning the charge that material classified as earth in one monthly estimate was afterward returned as rock in succeeding estimates, Mr. Adams says this was done to give the Resident Engineers (each of whom had about 100 miles of work under their charge) time to reach various portions of the work and reach a decision upon the nature of the material. Pending this decision, the local assistant engineers in charge returned all doubtful material as earth in their monthly estimates.

Embankment.

Under the specification there was no allowance for overhaul, but wherever materials had to be hauled over 1,000 ft. they were paid for as embankment, whether actually placed in the canal banks or dumped on spoil banks. The Commission thinks it would have been better to have paid directly for overhaul, and thinks that there has been a tendency to put material on spoil banks which would have been made use of had the contractor not received payment for the material so wasted as embankment. Mr. Adams' reply to this is that this use of the term "embankment" has been common practice on the State canal work for years, and that overhaul cannot be paid for on canal work as on railroad construction because to sort out the material suitable for putting in the banks requires hauling in all sorts of directions, and it would require a small army of engineers to record the measurements and the distances hauled. He further states that the great bulk of the excavated material from the canal prism, which it was supposed would serve for the necessary embankments, was found unfit for that purpose on its removal, and gives this as the reason why the embankment, which was only 739,374 cu. yds. in the preliminary estimate, had already, on May 1, 1898, reached 1,167,849 cu. yds.

Lining.

The Commission criticised the use of cinders as lining on some contracts. Mr. Adams holds that cinders constitute one of the very best of lining materials, and says that by their lightness, as compared with other lining materials, they have certainly saved the rebuilding of several structures that would have been forced into the canal by the weight of almost any other material available. He holds that because they could be, in some cases, obtained more cheaply than gravel by the contractor, was no reason against their use.

Money Expended for Ordinary Repairs.

The Commission estimated that about $1,500,000 had been spent for ordinary and extraordinary repairs out of the $9,000,000 appropriation, which should have been provided for from other sources; and it referred to this sum in its report as "improperly expended," Mr. Adams points out that since there was no "other fund" to draw upon, the canal engineers had to make necessary repairs from the $9,000,000 appropriation. If the work of deepening the canals endangered bridges, aqueducts and other structures, as it frequently did, it was necessary to repair them or run the risk of a break and serious damage. He contends that a real injustice has been done the Engineering Department by this statement, since the Commission knew that the work to be done was absolutely necessary.

The Commissioners' further charge that another $1,000,000 had been misspent, as a result of poor specifications, loose methods or improper management, he meets with specific denial, and declares that while absolute perfection is not attainable in any work of such magnitude, it is believed that the total amount improperly spent on the work does not equal the cost of the Commission's investigation.

Lock Improvement.

The State Engineer obtained working detail plans for three kinds of lift locks for Lockport, paying the following sums therefor:

Buffalo Engineering Co.	$19,079
Stowell & Cunningham (another style)	8,811
Dutton Pneumatic Lock & Engineering Co., for a pneumatic lock	14,500
Dutton Co., for plans for locks at Cohoes	7,000
	$49,390

The Commission held that this work was not properly a part of that contemplated by the $9,000,000 appropriation, and holds that it was not necessary to obtain complete working plans of three separate devices before choosing between them. Mr. Adams declares that the completion of the lock lengthening was mandatory by the terms of the law, and that at Lockport the only alternative to the adoption of a lift lock would be the closing of the canal for one season. He further says that when the plans for this work were ordered, it was believed that there would be money enough to build these locks from the $9,000,000 fund. After much study it was believed that three different types of lock were available at Lockport, and as none of these had ever been built it was deemed best to prepare detail plans of each type in order that an intelligent comparison might be made.

Berme Slope Walls.

Mr. Adams says that only 10½ miles of new slope wall has been built on the work, and then only where it was necessary to maintain the banks. The old slope walls could either be underpinned and saved or could be torn out to leave an earth slope. The former course was adopted, and it is believed that any other course would have subjected the engineers to severe and merited censure.

Water Supply.

Concerning the amount of excavation on the level above Lockport, Mr. Adams declares this was a necessity to give the canal sufficient cross-section to enable it to discharge sufficient water to feed the 62-mile level from Lockport to Rochester, without undue velocity of current. All the water used for milling purposes at Lockport is returned to the canal except that which is discharged into Eighteen-Mile Creek. The waste weir and waste gates discharging into this latter stream are necessary, however, to take care of surplus water, and if an honest man can be found to manipulate them, the State's interests will not suffer.

Besides replying to the general criticisms of the Commission, Mr. Adams takes up in detail and replies to many specific irregularities which were charged by the Commission. These, however, it would serve no useful purpose to present here, especially as the matter in controversy will probably be made the subject of judicial inquiry.

THE REPLY OF SUPERINTENDENT OF PUBLIC WORKS ALDRIDGE TO THE CANAL INVESTIGATING COMMISSION.

On Oct. 30 the Superintendent of Public Works, Mr. Geo. W. Aldridge, made public a reply to the charges made in the report of the Canal Investigating Commission. At the outset he calls attention to the fact that the report commends the character of the work done, and declares that the contracts were regularly awarded under actual and wide competition. He further says that the Commission "fails to find any condition, any official act, or any intimation that would warrant a suspicion that I have profited either directly or indirectly through the prosecution of this work."

Taking up the report in detail, he calls attention to the fact that the Commission did not pursue very far the question of who was responsible for the fixing of the canal appropriation at the inadequate sum of $9,000,000, and for leading the voters to believe that that sum would be sufficient for the work of deepening the canals to 9 ft. It appears to be clearly the case that the responsibility for this does not lie with either Mr. Adams or Mr. Aldridge, but with the Executive Canal Committee, and with this body, Mr. Aldridge points out, some of the members of the Investigating Commission were closely identified. He suggests a reason for the failure of the Commission to investigate this subject very far as follows:

The member of Assembly who introduced the bill calling for the appropriation of $9,000,000, had in his desk, at the time that bill was introduced, a bill identical with that bill, except that it called for several million more dollars. The introduction of the bill was delayed pending a conference of gentlemen interested in the subject of canal improvement. The conference took place and the main subject of the discussion was as to whether the larger or smaller amount of money should be asked for. The line of the discussion did not run as to whether the work could be accomplished with the $9,000,000 instead of the larger sum, but rather which sum the people were the more likely to grant. I believe the thinking public will be able to see that there may possibly be a motive in the refusal and failure of the commission to satisfy the public on points of deception involved in the question of canal improvement. Perhaps, also, they will see that it was highly desirable, if not absolutely necessary, in order to blind the public as to the responsibility for this deception, to cast aspersions, accuse by innuendo and condemn by wholesale, officials having to do with the expenditure of the improvement funds, even though the work were well done, and even though no suspicion of dishonesty could attach to the public officials in order that they (those interested in canal improvement) might read their titles clear to further appropriations.

Continuing, Mr. Aldridge says that it is nothing strange if in the light of the experience already had with the canal work, better methods could now be suggested for doing some parts of it. "Hindsight is usually better than foresight." Nevertheless, considering the very unfavorable season in which the work had to be chiefly done

in order not to interfere with navigation, he "challenges the Commission or the public in general to point to any work of similar magnitude where greater diligence has been shown or where the estimates have come as near to accomplishing the work required to be done as has been accomplished in this instance," and he presents the following comparison of the original estimates and actual costs of various notable public works:

	Cost, Estimate.	Cost, Actual.
Erie Canal	$4,926,738	$7,143,789
Enlargement	23,402,863	32,068,851
Oswego Canal	227,000	565,437
Enlargement	1,926,339	2,511,992
Champlain Canal	871,000	1,746,062
Black River Canal	1,068,437	3,157 296
Hoosac Tunnel	1,948,557	20,241,842
Manchester Ship Canal	26,000,000	67,351,105
Chicago Drainage Canal	12,000,000	*37,671,652
Hudson River Improvement	2,000,000	†2,600,000
State Capitol, Albany, N. Y.	4,000,000	24,000,000

*This includes $27,303,216 already expended and an estimate of $10,358,436 to complete work.
†This amount is estimated as needed over and above the first $2,000,000.

Taking up the report seriatim, Mr. Aldridge denies that he had claimed that his responsibility for the character of the work done was limited to the masonry. He also denies, however, that he is in any way responsible for the character of the engineering work on the canals, or that he has discretion to withhold the payments to contractors upon the engineers' monthly estimates except he be in possession of convincing evidence that fraud is being perpetrated, by which the state is to suffer.

In proof that the inspectors as a whole faithfully performed their duties, Mr. Aldridge points to the Commission's declaration that "the quality of the work is generally good, and an improvement upon that heretofore done on our canals."

In reply to the Commission's criticism that there was at times delay in awarding contracts after the receipt of bids, Mr. Aldridge says that after bids were verified and tabulated, it was the practice to refer them to the State Engineer for an opinion as to whether the bids were unbalanced. Necessary absences of the officials in either department might cause some delay in the award of bids.

Mr. Aldridge defends his expenditures for advertising, and holds that the wide publicity thus secured bore its fruit in the very low unit prices under which it is admitted on all hands the contracts were let. If the competition secured by the wide advertising reduced the average price 1 ct. per cu. yd., the saving would pay the entire cost of the advertising.

Concerning the inspectors employed, Mr. Aldridge says that the entire force was subjected to civil service examinations, except at one exigency, when no candidates could be obtained through civil service methods. He denies that any inspector was appointed at any time for political reasons.

The reason why the material excavated from the canal prism was not used in raising the canal banks was that it was in most cases unfit for that purpose. It was, however, used so far as practicable to strengthen the rear of embankments.

Extra work and the overrunning of quantities in the actual work as compared with the engineer's estimate are reviewed by Mr. Aldridge, and he contends that the practice followed is that which is common in the execution of all public works, and that the State suffered no loss whatever. The carrying on of the work on the Jordan Level on a force-account basis was the only method by which it could possibly have been rushed through in time to have the canal ready for use at the opening of navigation.

Mr. Aldridge further replies to the criticisms of the Commission relative to the excavation west of Lockport, the filling of the old basin at Syracuse, and the making of "ordinary repairs" from the canal improvement fund, and concludes his report as follows:

> I wish to say finally that every expenditure from the $9,000,000 fund can be justified in a court of law. No work has been done and paid for out of the fund, excepting that which needed to be done and which is incident to the general improvement. The sweeping statement that a million dollars has been unlawfully expended I repudiate as false, as I do the other suggestion that a million dollars or more has been wasted. Because a sum aggregating upwards of two millions of dollars has been expended for work which hurried plans and surveys could not foretell as needing to be done, is not warrant for any man or any body of men to make the sweeping statement that that sum has been misspent.
>
> One of the eminent engineers attached to the commission has been so fair as to say that the whole trouble lies with the system. While I am willing to be judged by my acts I claim it as unfair that I should be held responsible for a system that has been the outgrowth of three-quarters of a century's conduct of the state's affairs. This same engineer has also said that the state engineer and myself have done as well as, and accomplished as much as, any others could have accomplished under the same conditions; and also that the money paid out has procured as much work as could probably be expected. I desire to go farther and make the prediction that if the improvement is to be continued no better work will be obtained or less money expended for the same character and amount of work.

ANNUAL CONVENTION, AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

The fifth annual convention of the Society was held on Oct. 26, 27 and 28, the place of meeting being the Arlington Hotel, Washington, D. C. At the opening session about 60 members were present, but the arrival of other members daily throughout the convention increased the total attendance to 75 or 80. The program was a long one, including a full score of papers, and special and standing committee reports on various questions of municipal improvements, besides the reports of officers, address of welcome, president's address, election of officers and other necessary business, which consumed the whole of one session and portions of two other sessions. In the technical part of the proceedings, the most attention was devoted to questions of sewerage and sanitation, roads and pavements, and water supply, and this report of the convention work will be divided under these three general heads, and the general head of miscellaneous without regard to the exact order in which the several reports and papers were presented. In this way all the information relating to each general phase of municipal work will be collected in one place so far as this report presents it.

Routine Convention Business.

The first session was devoted entirely to the opening exercises, and the transaction of routine business. After a few brief introductory remarks, Mr. Harrison Van Duyne, President of the Society, introduced Mr. John B. Wight, President Board of Commissioners, District of Columbia, who gave a brief address of welcome to the Convention. Mr. Wight referred to Washington as distinctly a residential city, but stated that it would possibly surprise most of the members to learn that, in proportion to its population, the city also stood fourteenth in the list of manufacturing cities of the country. Mr. Wight also described briefly the progress made by the city in municipal improvements and explained the fiscal system of the District of Columbia and the manner in which it was governed. Speaking of the improvements in prospect, he said:

> Plans are now perfected by which the steam railways will remove their tracks from the streets and do away with the objectionable and deadly grade crossings; the unsightly and unhealthy Eastern branch flats, which are such a menace to health, are soon to be reclaimed; a recent law of Congress will enable us, within a very short time, to compel every house to be connected with running water and supplied with the latest sanitary conditions; a careful study is being made of the subject, with the expectation that soon legislation will be passed enabling us to take down every overhead wire that now exists, and put it under ground.

After a fitting response to Mr. Wight's remarks, President Van Duyne read his formal address to the Convention. The President referred briefly to the meeting places of the four preceding conventions of the Society, and mentioned the value of the information which could be obtained by such visits to the different large cities of the country, and thus ascertaining by personal inspection the results of their systems of municipal organization and management. Turning to the more concrete questions of the Society's work, he said:

> At the convention held last year our committee on street paving recommended, among other things, that where a contractor was required to guarantee his work for a term of years, especially in asphalt pavement, the condition of the pavement at the end of the term should be specifically stated. The city of Newark, N. J., this year partly adopted these suggestions, and instead of paving with asphalt under specifications calling for a five-year guarantee with indefinite requirements, it now requires a ten-year guarantee under bonds given by a responsible trust company, and the exact condition in which the pavement is to be at the end of that term in order to be accepted is stated. Under the old specifications for several years only Trinidad Lake asphalt was used. Last year the bidders were limited to four different kinds, and this year, under the more severe and definite specifications, the door was thrown wide open to all asphalts. Any responsible company or individual giving approved bonds is given the contract, provided the bid is the lowest.
>
> The first asphalt laid in Newark was in the year 1890, and from that time until 1894 it cost about $2.85 per yd. This was laid by the Barber Asphalt Co., and virtually without competition. Last year the price got down to $2.35 per yd., and this year, with the ten-year guarantee, but open to all, the price has been about $1.50 per yd. The city, however, agrees to pay in addition to that amount 25 cts. per yd. for the second term of five years for maintenance and repairs.
>
> We have also required this year a five-year guarantee on oblong granite block pavement, notwithstanding which the price has been reduced from about $2.50 per yd. in 1893 and 1894 to $1.50 per yd. this year when laid on sand, and in like proportion when laid in concrete. Perhaps I should add that New York city, only nine miles away, stopped almost entirely its paving work this year, and that may have helped to reduce the price to the neighboring cities.
>
> The great advance made during the last few years in city development has taken a large amount of money, the annual outlay for expenses has been greatly increased, municipal bonds are becoming a burden, and as a natural result there is such an increase in the tax rate as to cause alarm to many citizens. During this same time in all our cities a wonderful advance has also taken place in the value of the franchises which have been given to so many companies, to use the public streets to carry on their business.
>
> These franchises are worth nearly as much as the land fronting on the streets through which their grants and privileges extend. They have a recognized value to buy and sell, and their earnings and dividends bear out that value; but when it comes to the valuation on which they pay taxes there is a wonderful drop, and the result is that they bear only a small part of the public burdens that properly belong to them, and the tax burdens of others are proportionately increased. I know of no reason why, according to the true value of these properties, they should not contribute their share to the support of the public schools, to the cost of maintaining our courts, and all the other expenses of city and state government, the same as other property.

The next business was the election of members, and 29 new names were added to the roll. The Secretary's report showed that during the past year the income of the Society had been $601.50, and its expenditures the same. In the report of the Treasurer, which followed, the fact was brought out, however, that this satisfactory showing of the Society's finances had been made possible only by the President paying $100 out of his own pocket, and by the Secretary not drawing his salary, which amounted to an additional $100. At present there was in the hands of the Treasurer an unexpended balance of $6.72. The report of the Finance Committee stated further that the present indebtedness of the Society was $210, or, deducting the $6.72 cash on hand, $203.28, and it recommended, in order to clear away this indebtedness, that the dues for the coming year should be increased to $5 for each member. Several further recommendations were made in the report of the Executive Committee, which was next read, all designed to place the affairs of the Society on a more satisfactory basis. All of these recommendations required changes in the Constitution of the Society, and the most important one was that cities should be dropped from the roll of membership and that each individual member should be charged an annual due of $5. These recommendations were adopted by vote of the Convention.

The following officers were elected to serve the Society during the coming year: President, Nelson P. Lewis, Brooklyn, N. Y.; First Vice-President, A. D. Thompson, Peoria, Ill.; Second Vice-President, P. H. Thomas, Parkersburg, W. Va.; Third Vice-President, B. H. Colby, St. Louis, Mo.; Secretary, D. L. Fulton, Allegheny, Pa.; Treasurer, John L. Kennedy, Nashville, Tenn., and Finance Committee, F. J. O'Brien, Oswego, N. Y.; F. A. Twamley, Grand Rapids, Mich., and G. S. Vichery, Bangor, Me.

By vote of the Convention, the city of Toronto, Ont., was selected as the place of meeting of the 1899 Convention of the Society.

Sewerage and Sanitation.

Report Upon the Utilization of Sewage of Vienna, Austria.—This was a translation by Capt. Lansing H. Beach, Engineer Commissioner, Washington, D. C., of the report of the special commission appointed to investigate the question of disposing of the sewage of Vienna, Austria, by utilization and especially to study its fertilizing qualities. The report was of great length and contained numerous tables and only the very briefest summary of its conclusions is possible here. The report stated that the fertilizing material in a cubic meter of Vienna sewage was worth from 3.5 to 15.7 kreutzers, a kreutzer being worth somewhat less than 1 ct. in American money. The commission considered that direct transportation of the sewage to the available land affording an opportunity for such fertilization was not feasible, and that a reduction to powder could not profitably be accomplished. The conduction of the entire sewage to the irrigation fields by canal was recommended as on the whole the best plan, but the commission concluded that while irrigation could be successfully carried out, the system could not be conducted under methods now known at an actual profit. These conclusions, of course, related to the conditions at Vienna only.

Sewerage of Baltimore.—In this paper Mr. Kenneth Allen, Principal Assistant Engineer, Sewerage Commission, Baltimore, Md., outlined briefly the system of sewerage, or rather lack of sewerage, in the city of Baltimore, Md., and described the system recommended by the special commission appointed in 1893 (Eng. News, Dec. 30, 1897). As will be remembered the commission considered either of three plans of disposal available: (1) Dilution in Chesapeake Bay; (2) chemical precipitation, and (3) agricultural filtration. The last named was considered the most perfect method of disposal, but on account of its great cost the commission recommended diultion in Chesapeake Bay as preferable for Baltimore. Mr. Allen stated that this method of disposal was, however, seriously objected to by the oyster trade.

Proposed Sewage Disposal System for Washington, D. C.—In this paper Mr. D. E. McComb, Superintendent of Sewers, Washington, D. C., gave an interesting historical outline of the development of Washington's system of sewers from the first drainage work of 1832 until the present year. Since 1890 the work had followed in all important respects the plans recommended by the board of engineers, consisting of Messrs. Rudolph Hering, Samuel M. Gray, and Frederic P. Stearns, which was appointed by Congress to devise a comprehensive system of sewerage

for the city. The amount required to carry out these plans was $3,257,635, and up to the present time the sums expended and available for spending aggregated $772,000. At the present rate of expenditure Mr. McComb stated that the completion of the system as planned might be expected about the year 1925. The paper concluded with a brief description of the rules followed in the sewer construction of the district, from which we abstract the following items:

Sewers between 8 and 24 ins. in diameter are made of stone-ware pipes laid upon a cradle of concrete masonry, the joints being covered with a concrete enveloping band. Above 24 ins. diameter they are made egg shape until the 4 ft. × 6 ft. size is reached, which is the largest regular section; sewers above that size are considered exceptional and are designed with reference to the location and conditions.

In main sewer work that portion of the sewer which is below the springing line is constructed of concrete masonry, lined with a wearing surface of vitrified brick masonry from the bottom to a line midway between the bottom and the springing line. Above the vitrified brick masonry the lining is of ordinary brickwork, the same thickness as the vitrified brick masonry. In sewers 4 ft. × 6 ft. and smaller, stone ware inverted blocks are laid in addition to the lining of vitrified and ordinary brick masonry, described above. In a few cases of sewers having light gradients, constructed in dry ground, and designed to convey sewage only, unlined concrete sewer inverts have been constructed with satisfactory results. The arches of main sewers are constructed either of ordinary brick or concrete masonry, the selection being controlled by local conditions.

Concrete masonry used in pipe sewer work and elsewhere in walls less than 6 ins. thick is composed of beach pebbles, each particle of which must pass through a 1¼-in. ring, mixed with an amount of mortar (composed of cement 1 part, sand 2 parts) which shall be 30% in excess of the volume of voids in the gravel.

Concrete masonry in more massive construction is composed of broken stone, each fragment of which must pass through a 2-in. ring, gravel and mortar. The amount of gravel used equals the volume of voids in the broken stone, and the amount of mortar is 30% in excess of the volume of voids of the mixed stone and gravel.

Some Observations on the Effect of Flushing Devices for Small Sewers—This paper, by Mr. A. E. Phillips, Assistant Engineer, Sewer Department, Washington, D. C., described briefly a short series of experiments made in Washington to determine the action of the discharge of flush tanks in respect to the velocity and depth of the wave produced. The substance of the paper was comprised in a half-dozen or so of diagrams and will be given more fully in a future issue. Briefly stated, however, the diagrams showed the discharge to have a true piston action, that is, the discharge assumed the form of a wave and progressed in this form the whole length of the sewers tested. The velocity of this wave, its volume and length, and the steepness of its front and rear faces varied with the grade of the sewer, and with other conditions. So far as they went, the experiments demonstrated the efficiency of flush tank discharges for scouring sewers of small diameter.

Discussion.—The discussion which followed these four papers was quite brief, and was confined principally to questions by the different members to make clear parts of the papers which had not been fully understood in their reading. In reply to one of these questions Mr. McComb stated that the cost of concrete sewers, as constructed in Washington, was to the cost of brick sewers of the same size about as 7½ to 9. Mr. Phillips stated that altogether there were in use in Washington about 100 flush tanks, all placed at the dead ends of small sewers. These tanks required inspection and repairs as did any other device, and when kept in good order they worked satisfactorily.

Streets and Pavements.

The consideration of the various questions under this heading was opened by a brief paper by Mr. N. P. Lewis, Engineer of Street Construction, Brooklyn, N. Y., which treated chiefly of questions relating to the construction and maintenance of pavements along and between the lines of surface street railways. The paper described the standard street railway track constructions used in Denver, Colo., Detroit, Mich., Cincinnati, O., Minneapolis, Minn., and Washington, D. C. Following Mr. Lewis's report, came a series of tables giving the cost of repairing asphalt pavement in Buffalo, N. Y., which were furnished by Mr. Edward B. Guthrie, M. Am. Soc. C. E. These tables will form a part of the city engineer's coming report, and will be published in that document. In this same connection, Capt. Lansing H. Beach, Engineer Commissioner, District of Columbia, announced that in the coming report of the commissioners to the President, similar figures would be published for all asphalt pavements in the city of Washington. The next paper read was entitled "The Proper Curbing of Streets," and was presented by Mr. Horace Andrews, City Engineer, Albany, N. Y. This was followed by a paper entitled "A Street Extension Plan for the Entire District of Columbia," by Mr. Wm. P. Richards, Assistant Engineer, Washington, D. C.

Relative Values of Paving Materials.—In this paper, Mr. Geo. W. Tillson, Brooklyn, N. Y., presented an attempt to provide a practical working plan for determining the best paving material for any given set of conditions. He divided the desirable qualities for pavements into eight, and allotted to each a certain percentage of the total value, which was, of course, 100. From such information as he could obtain, the writer then allotted to each of the more common paving materials a numerical standing, under each heading. This gave the following table of relative values:

	Values.							
	Standard.	Granite: A*.	Granite: B.†	Asphalt.	Brick.	Belgium.	Macadam.	Cobble.
Cheapness, first cost.	15	2	4	4	3	5	7	14
Durability	21	21	17	13	13	17	7	15
Ease of cleaning	15	11	8	15	12	7	5	2
Resistance to traffic.	15	7	5	15	11	5	5	3
Slipperiness	7	6	5	3	6	4	7	5
Maintenance	10	10	7	6	6	7	3	2
Favorableness, travel.	5	3	2	5	4	2	6	0
Healthiness	13	9	7	13	10	5	5	2
Total	100	69	55	74	65	52	44	43

*Concrete Foundation.
†Gravel and sand foundation.

Tree Planting in the Streets of Washington.—In this paper Mr. Wm. P. Richards, Assistant Engineer, Washington, D. C., stated that in Washington, unlike the practice in most cities, tree planting in the streets was carried on and controlled by the city authorities. The city had a nursery, in which it raised the trees for transplanting, and on an average from 1,000 to 3,000 new trees were planted in the streets each year. The paper enumerated the different kinds of trees which had been employed, and gave their relative value for street use. In order of merit, he placed silver maple, Norway maple and Eastern plane (Platanus orientalis) side by side. In the second rank came the gingko, or maiden hair tree, and the Western plane. Last of all came the American linden, the oak and the sugar maple, which demanded more care, and were especially suitable to wide parkings.

Electric Street Lighting.—The report of this committee was made by Mr. F. W. Cappelen, City Engineer, Minneapolis, Minn. Reviewing the list of cities from which figures of the cost of electric street lighting had been collected in 1896, the report stated that information recently obtained showed that about 30 of them had reduced the price per lamp. In an appendix the report reviewed the experience had with the municipal electric lighting plant at Detroit, Mich., quoting in full the editorial on the report of the Public Lighting Commission of Detroit, published in Engineering News, of Sept. 8, 1898.

Street Cleaning and Disposition of Garbage.—This paper, by Dr. A. K. Reynolds, of Chicago, Ill., was a short and somewhat superficial study of the question of garbage collection and disposal in the city of Chicago. Mr. Reynolds considered that preferably the city should collect the garbage, but in case the work was contracted for, separate contracts should be let for collecting the garbage proper and for collecting the ashes. He also favored regulating the junk trade, so as to make it give an income to the city. The disposal of garbage, Mr. Reynolds regarded as in an experimental stage. He spoke favorably of the possibilities of Lord Kelvin's plan for producing power from the burning of garbage, and gave a variety of figures going to show the value of the commercial products contained in garbage. Mr. Reynolds, however, failed to mention the counterbalancing cost of reduction.

Discussion.—The discussion coming under this division of the convention's work was confined almost entirely to the cost and maintenance of asphalt pavements, and to the closing paper on garbage collection and disposal. Dr. W. C. Woodward, Health Officer, District of Columbia, criticized the idea of separate contracts for collecting garbage and ashes. He thought that a single contract for the collection of both much preferable, for the reason that in the winter the collections of garbage were light and those of ashes were heavy, while in the summer the exact contrary was the case, and if a single contractor made both collections, he could utilize his labor and plant more efficiently by turning them first to one task and then to the other. In Washington, householders were required to keep the garbage and ashes separate and to deposit the garbage in metal receptacles, holding not less than ten and not more than thirty gallons. The collection of garbage, ashes and dead animals was by contract at a cost of $57,000. From April 15 to Nov. 1 daily collections were made, and from Nov. 1 to April 15 the collections were semi-weekly. Disposal was accomplished by towing the garbage down the river in barges and either dumping it, or more generally ploughing it under land for fertilization. The contractor for collection was also the contractor for disposal, and owned the land upon which the refuse was thus employed. The city had had experience with two forms of crematories during the past, and neither had been satisfactory under all conditions and at all times. Mr. Woodward doubted if there was much profit in garbage reduction with present methods, providing sanitary and inoffensive treatment was ensured under all conditions.

Mr. John Jones, Street Commissioner, Toronto, Ont., stated that in that city all garbage and refuse was collected by the city, it having its own plant of carts and horses, even including its own harness-maker, blacksmiths, etc. About 120 horses and carts are employed, and the bulk of the collections were in the winter months. In summer the extra horses were employed on the street sprinkling carts. The city had two crematories for burning its garbage and refuse. He believed that the municipality itself could collect its garbage much better and more cheaply than it could be done by contract.

Water-Works and Water Supply.

The various papers coming under this heading were introduced by a brief verbal report of the special committee on the subject, of which Mr. M. L. Holman, M. Am. Soc. M. E., of St. Louis, Mo., was the chairman. Mr. Holman considered that the great question in water supply which at present demanded attention in the United States, and particularly in the more densely settled States of the East, was the protection and cleansing of this supply from impurities. He described the work which had had to be done in Europe along these lines, and outlined briefly the theory and methods of sand filtration so extensively used abroad. In the United States, he thought, the time had arrived when National legislation for the protection of sources of public water supply from pollution should be agitated. The questions to be considered were, first, the condition of such supplies; second, the remedy to be adopted, and, finally, the best method of enforcing this remedy. He urged that the Society should take the matter up, and use its efforts to secure adequate National legislation.

Electrolysis at Dayton, O.—In this paper, Mr. Harold P. Brown, New York, N. Y., described the very thorough investigations of damage by electrolysis of water mains at Dayton, O., which were outlined in our issue of Oct. 6, 1898. The conclusions of the paper were:

(1) It will not be a mistake to follow Dayton's example and obtain complete and accurate information concerning the electrical, chemical and mechanical condition of your pipes, especially in the vicinity of the power house. The trouble may be confined entirely to the lead in the service pipes, and in the calking of joints on your mains; but even here serious damage may result if the matter is neglected for years.

(2) Do not put down any more lead or wrought iron service pipes, as these are the first victims of electrolysis, and their replacing means ruin to pavements. Use instead wooden pipe, banded with a close spiral of hoop iron and covered heavily with asphaltum. This will stand the heaviest pressure in use and is not affected by electrolysis, since the hoop iron is low in conductivity, and is not electrically connected at the joints. Its cost is said to be reasonable, and it has a successful record of many years' service.

(3) Use the same kind of pipe for new mains in any district in which a railway power house is likely to be erected and heavily paint the lead calking of cast iron mains, using asphalt or peroleum wax.

(4) In the danger district along these lines of electric roads and on intersecting streets put into your water and gas mains two or more consecutive lengths of these wooden pipes, so as to break the electrical continuity of the mains and thus make their resistance greater than that of the rails. Fill in the space around them with broken stone and connect with drain if possible.

(5) Midway between the wooden sections on each main attach insulated pilot wires, leading to a central office. Connect similar wires to the rails nearest the pipe and make daily electrical tests at times of heavy load. If any section shows positive to the rails, cut it at once into smaller sections and call upon the railway to rebond its line upon that street. This, with the proper electrical management of the railway feeder wires and apparatus, will effectively protect your mains.

The last paper coming under this heading was by Mr. L. W. Rundlett, City Engineer, St. Paul, Minn., and was on "The Coating of Cast Iron and Steel Riveted Pipes." Mr. Rundlett gave briefly such records of experience with pipe coatings as had been brought out since his more comprehensive paper on the same subject presented at Nashville, in 1897, and published in the 1897 "Proceedings of the Society."

The discussion was quite brief, and was confined principally to the paper on electrolysis. Referring to the recommendations of Mr. Brown for preventing electrolysis Mr. M. L. Holman, St. Louis, Mo., believed that the railways should be required to provide such perfect return circuits that no electricity could get into the ground. Mr. G. H. Benzenberg, Milwaukee, Wis., believed that the proper solution of the question was to recognize the fact that some electricity would certainly get into the pipes, and should be taken care of without damage to the pipes by leading wires from them to a connection with the negative pole of the dynamo. He also took pains to make his water pipes as perfect a return circuit as possible.

Miscellaneous Papers.

Taxation and Assessment.—Mr. August Herrmann, President, Board of Administration, Cincinnati, O., presented in his report upon this topic statistics covering taxation and assessment in 29 American cities, all having over 80,000 population. The figures were very complete, and they will be referred to more fully by Engineering News when they are available for more careful study and comparison.

Municipal Data.—The committee upon this subject, the chairman of which was Mr. C. C. Brown, City Engineer, Bloomington, Ill., advocated the establishment of a bureau of municipal data by the Federal Government, whose duty it should be to collect information concerning the various phases of municipal work, including public improvements, and present a report each year. This bureau, it was suggested, should be a branch of the census bureau, which should be made a permanent bureau. The report contained forms for reports for water-works, sewerage and street improvement work. Upon vote of the convention the executive committee of the society was instructed to take the recommendations of this report under consideration, with power to act in the matter as it deemed best.

The concluding report on "Yearly Review" was presented by Mr. G. H. Benzenburg, and as its caption indicates, was a general review of the field of municipal engineering for the year of 1898.